MARCH 1987 MDC W5108

Space Station

Mission Planning System (MPS) Development Study

Final Report
Volume II - Technical Report

PREPARED BY:
W. J. Klus
Project Manager

APPROVED BY: David A Bergeson
for E. M. Chewning
Manager, Space Station Projects

PREPARED FOR THE NATIONAL AERONAUTICS AND SPACE ADMINISTRATION. GEORGE C. MARSHALL SPACE FLIGHT CENTER. UNDER CONTRACT NO. NAS8-37275. EFFECTIVE DATE: 23 MAY 1986

MCDONNELL DOUGLAS ASTRONAUTICS COMPANY
HUNTSVILLE DIVISION
P.O. BOX 1181
HUNTSVILLE, AL 35807

CONTENTS

Page

LIST OF FIGURES iv

LIST OF TABLES iv

Section 1 INTRODUCTION 1-1

1.1 Purpose 1-1
1.2 Scope 1-1

Section 2 STUDY OBJECTIVES AND APPROACH 2-1

2.1 Objectives 2-1
2.2 Technical Approach 2-1

Section 3 PROGRAMMATIC SUMMARY OF STUDY ACTIVITIES AND ACCOMPLISHMENTS 3-1

Section 4 TASK 1 - ORIENTATION 4-1

Section 5 TASK 2 - REVIEW SPACELAB MISSION PLANNING PROCESS AND SOFTWARE 5-1

5.1 Activities and Accomplishments 5-1
5.2 Spacelab Mission Planning Process 5-2
5.2.1 Spacelab Functional Flow 5-2
5.2.2 Detailed Flow Diagrams 5-9
5.2.3 SL MIPS Data Base 5-9

Section 6 TASK 3 - DEVELOP SPACE STATION MISSION PLANNING CONCEPT AND SOFTWARE REQUIREMENTS 6-1

6.1 Activities and Accomplishments 6-1
6.2 Space Station Mission Planning Concept 6-2
6.2.1 Introduction 6-1
6.2.2 Definitions, Groundrules and Assumptions 6-2
6.2.2.1 Space Station Physical Configuration 6-2
6.2.2.2 Space Station Flight Operations Scenario 6-3
6.2.2.3 Scope of Payload Mission Planning 6-3
6.2.2.4 Approach to Payload Mission Planning 6-4
6.2.3 SS Payload Mission Planning Process Functional Description 6-10
6.2.3.1 Subfunction 1 - SS Projected Orbit Ephemeris 6-10
6.2.3.2 Subfunction 2 - Standard Orbit Opportunities Generation 6-10
6.2.3.3 Subfunction 3 - Special Observation Opportunities Generation 6-18
6.2.3.4 Subfunction 4 - User Requirements Definition And Data Base (URDB) Interface 6-18
6.2.3.5 Subfunction 5 - Generate Planning Center Integrated Requirements 6-18

CONTENTS (Cont'd)

Page

6.2.3.6 Subfunction 6 - Integrated Assessment of Planning Center Summary Requirements 6-18
6.2.3.7 Subfunction 7 - Assign User Resource Allocation Envelopes 6-18
6.2.3.8 Subfunction 8 - Generate Planning Center Gross Timeline 6-34
6.2.3.9 Subfunction 9 - Integrated Assessment of Planning Center TOP's 6-34
6.2.3.10 Subfunction 10 - Generate User Activity Plans 6-34
6.2.3.11 Subfunction 11 - Integrate User Activity Plans 6-34
6.2.3.12 Subfunction 12 - Integrated Assessment of Planning Center Activity Plans 6-43
6.2.3.13 Subfunction 13 - Generate User Command Plan 6-34
6.2.3.14 Subfunction 14 - Generate Integrated Payload Data Flow Plan 6-45
6.3 SS MPS Software Requirements Summary 6-48

Section 7 TASK 4 - INVESTIGATE ARTIFICIAL INTELLIGENCE APPLICATIONS 7-1

7.1 Activities and Accomplishments 7-1
7.2 Definition Of Artificial Intelligence 7-1
7.3 Survey of AI Technology 7-1
7.3.1 Expert Systems
7.3.1.1 Training and Instruction 7-1
7.3.1.2 Trending and Prediction 7-3
7.3.1.3 Design and Configuration 7-3
7.3.1.4 Information and Data Interpretation 7-3
7.3.1.5 Planning and Scheduling 7-4
7.3.2 Natural Language Interfaces 7-4
7.3.3 Automatic Programming 7-4
7.4 Assumptions Prior to Candidate Evaluation 7-4
7.4.1 ADA Software 7-5
7.4.2 Specialized AI Hardware 7-5
7.4.3 Conventional Hardware 7-5
7.4.4 Candidate Evaluation Criteria 7-5
7.5 Desired Attributes of MPS Tasks 7-5
7.5.1 Task Domain 7-5
7.5.2 Task Expertise 7-7
7.5.3 Task Interfaces and Methods 7-8
7.5.4 Organizational Issues 7-8
7.5.5 Management Issues 7-9
7.5.6 Proposed Users of Task 7-10
7.6 Artificial Intelligence Techniques 7-10
7.6.1 Representation of Knowledge 7-12
7.6.2 Manipulation of Knowledge 7-13
7.6.3 Control Strategies 7-14
7.6.4 Uncertainty Management 7-15
7.6.5 Automatic Programming 7-15

CONTENTS (Cont'd)

		Page
7.6.6	Explanation Capability	7-16
7.6.7	Meta Knowledge	7-16
7.6.8	Natural Language Interfaces	7-17
7.6.9	Design Capture	7-17
7.7	Methodology for Candidate Implementation	7-17
7.7.1	VAX Vs. Symbolics Architecture	7-17
7.7.2	ADA Language	7-19
7.7.3	LISP Language	7-20
7.7.3.1	Rapid Prototyping Environment	7-20
7.7.3.2	LISP Language Advantages	7-21
7.7.3.3	Tools Available	7-21
7.7.4	PROLOG Language	7-21
7.8	Results of Evaluation	7-22
7.8.1	Benefits/Concerns	7-22
7.8.2	Methodology Summary	7-25
7.9	Conclusions and Recommendations	7-25
7.9.1	AI Technology	7-25
7.9.2	Hardware/Software Architecture	7-25
7.9.3	Software Tools	7-25
Section 8	TASK 5 - SOFTWARE DEVELOPMENT PLAN	8-1
Section 9	CONCLUSIONS AND RECOMMENDATIONS	9-1
Appendix A	SPACELAB MIPS DATA BASE	A-1

FIGURES

Number		Page
2.2-1	SS MPS Development Study Task Flow	2-2
3-1	SS MPS Development Study Schedule	3-2
5.2.1-1	Spacelab Funcional Flow	5-3
5.2.2-1	Spacelab Flow Diagram Conventions	5-11
6.2.2-1	Discipline Centers Integration	6-7
6.2.2-2	Element Centers Prime Integration/Discipline Centers Indirect	6-8
6.2.2-3	Discipline Centers Plus Element Centers Integration	6-9
6.2.3-1	Space Station (SS) Payload Mission Planning System (MPS) Top Level Functional Flow	6-11
6.3-1a	SS MPS SW Hierarchy	6-49
6.3.1b	SS MPS SW Hierarchy	6-50
7.1-1	Task 4 Flow Chart	7-2
7.5-1	Attributes of MPS Tasks	7-6
7.6-1	AI Techniques for MPS Tasks	7-11
7.7-1	AI Methodology for MPS Tasks	7-18

TABLES

Number		Page
5.2.1-1	Spacelab Functional Flow Activity Groupings	5-4
5.1.1-2	Acronyms and Abbrevations	5-7
6.3-1	SS MPS Software Sets	6-51
6.3-2	SS MPS Software Requirements Summary	6-52

Section 1

INTRODUCTION

1.1 PURPOSE

The purpose of this volume is to provide a detailed description of the results of the Space Station (SS) Mission Planning System (MPS) Development Study.

1.2 SCOPE

This volume includes a description of the overall Study objectives and approach in Section 2, a programmatic summary of Study activities and accomplishments in Section 3, a detailed presentation of individual task activities, methods and accomplishments in Sections 4 through 8, and a presentation of Study conclusions and recommendations in Section 9. Major products of the Study are contained in this volume and in Volume III, SS MPS Software Development Plan.

Section 2

STUDY OBJECTIVES AND APPROACH

2.1 OBJECTIVES

The basic objective of the SS MPS Development Study was to define a baseline Space Station mission planning concept and the associated hardware and software requirements for the system. Specific objectives in support of the basic objective were the following:

a. Develop a mission planning concept which is consistent with the overall Space Station operations philosophy.

b. Define and assess the capability of the Spacelab mission planning system software for use in Space Station mission planning consistent with the concept developed under objective a.

c. Determine and recommend where Artificial Intelligence (AI) concepts and techniques can be effectively utilized for Space Station mission planning. AI areas to be investigated for application to the specific requirements of mission planning include natural language interfaces, expert systems, and automatic programming.

d. Construct a software development plan for a phased development of a Space Station mission planning system. The plan shall consider the modifications identified in Objective b, and the implementation of any AI concepts recommended in Objective c. The plan shall include a schedule and a manpower estimate.

2.2 TECHNICAL APPROACH

The SS MPS Development Study included the following tasks to accomplish the study objectives:

Task 1 - Orientation
Task 2 - Review Spacelab Mission Planning Process and Software
Task 3 - Space Station Mission Planning Software Requirements
Task 4 - Investigate Artificial Intelligence Applications to Mission Planning
Task 5 - Mission Planning Software Development Plan

The flow of these tasks is reflected in Figure 2.2-1.

Task 1 was intended for the study team to obtain an initial familiarization with the process and existing software used for Spacelab payload mission planning at MSFC and to travel to other NASA centers to obtain a general familiarization with the processes and software in use for mission planning at those centers.

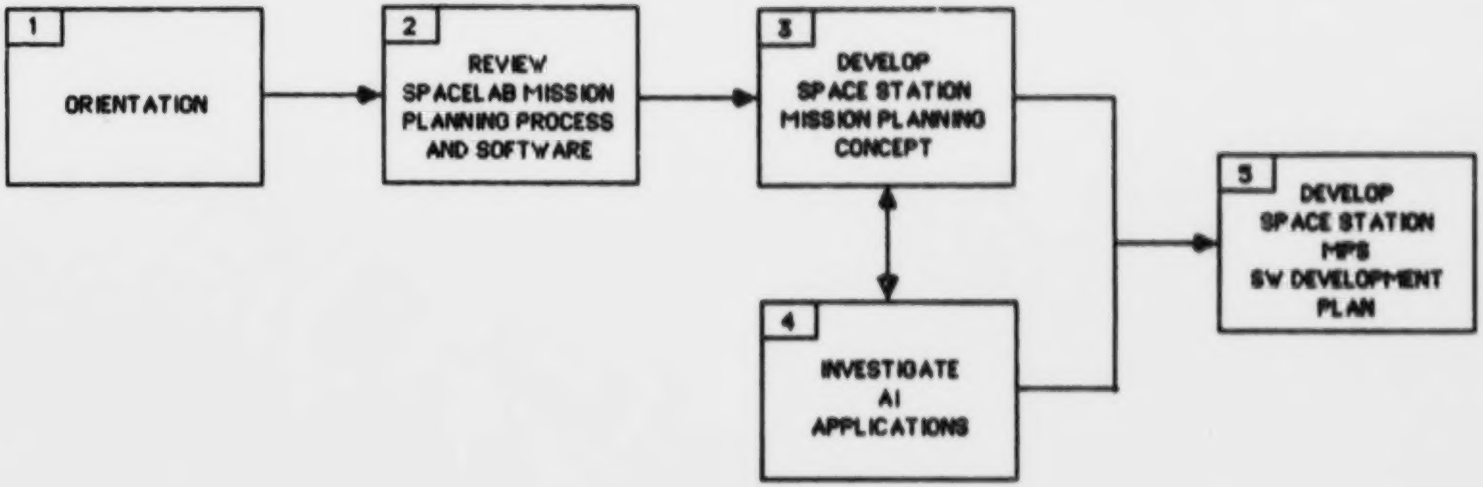

1
ORIENTATION
2
REVIEW
SPACELAB MISSION
PLANNING PROCESS
AND SOFTWARE
3
DEVELOP
SPACE STATION
MISSION PLANNING
CONCEPT
4
INVESTIGATE
AI
APPLICATIONS
5
DEVELOP
SPACE STATION
MPS
SW DEVELOPMENT
PLAN

FIGURE 2.2-1 SS MPS DEVELOPMENT STUDY TASK FLOW

The objective of Task 2 was to establish a complete baseline definition of the Spacelab payload mission planning process, along with a definition of existing software capabilities for potential extrapolation to the Space Station era. Areas to be included were orbital mechanics analysis and planning, mission timeline generation, data flow analysis and planning, onboard computer timelines generation and implementation, experiments command planning and implementation, and planning for Payload Operations Control Center (POCC) support. Pre-flight planning and real-time planning and replanning activities were also to be defined. The process definition was required to be defined using detailed functional flow diagrams, and individual software module functions were to be defined.

Task 3 was to use the information developed in Task 2 for the Spacelab payload mission planning process and software as the basis for defining system requirements to support Space Station mission planning. The system was required to include the capability to permit the mission planning function to be centralized or distributed, and to be performed by non-expert mission planners as well as experts. The role of mission planning onboard the Space Station and the interfaces with the ground were required to be assessed. Initially, five Space Station mission planning concepts were identified for assessment; these ranged from all mission planning done on the ground to all mission planning done on-board the Space Station. Subsequent MSFC guidance narrowed the possible concepts to one in which mission planning was to be done on the ground with minor real-time replanning capability to be provided on-board. Comparable to the Spacelab process, detailed flow diagrams of the Space Station mission planning concept were to be developed, including the flow of planning data. Also, software functions were to be identified, and modifications/additions to the Spacelab payload mission planning system software to support the Space Station mission planning concept were to be defined.

In Task 4, the Space Station mission planning concept (developed in Task 3) was to be reviewed for the purpose of identifying areas where Artificial Intelligence (AI) concepts might offer substantially improved capability. Three specific AI concepts were to be investigated for applicability: natural language interfaces, expert systems, and automatic programming. The advantages and disadvantages of interfacing an AI language with existing FORTRAN programs or of converting totally to a new programming language were to be identified.

Task 5 was intended to integrate the outputs of Task 3 and 4 to produce the primary product of the Study, a Space Station mission planning system software development plan. The plan was required to include:

- A detailed description of modifications and additions to the Spacelab mission planning system which are required in order to make this system suitable for use in Space Station mission planning.

- Recommendations on the use of AI as means of improving the overall mission planning process, including identification of specific areas where AI may be beneficial.

- A development schedule compatible with the overall Space Station schedules, and the manpower required.

The development plan was also required to include a description of the Space Station mission planning concept, a review of the functions to be performed, and a description of the modules required for each function. Module development standards, such as language used for coding, were also required to be defined.

Section 3

PROGRAMMATIC SUMMARY OF STUDY ACTIVITIES AND ACCOMPLISHMENTS

The SS MPS Development Study, as depicted in Figure 3-1, was originally intended to be an eight-month Study; however, six (6) months into the Study, the overall schedule was extended two (2) months to accommodate the longer (than originally anticipated) time to complete Task 2. Also, the extension provided the opportunity to support MSFC inputs to the NASA Space Station Operations Task Force and to incorporate appropriate Task Force concepts and conclusions into the Study.

An interim review of Study activities and accomplishments, originally planned for approximately four (4) months into the Study, was waived by MSFC in favor of weekly progress meetings. However, a formal presentation of the Spacelab payload mission planning process functional flow diagrams was made on 20 October 1986. Monthly progress reports were prepared and submitted as required and a final review of the Study was presented as required on 4 March 1987.

Study activities concluded with the submittal of a final report (of which this volume is a part) and a SS MPS Software Development Plan on 20 March 1987.

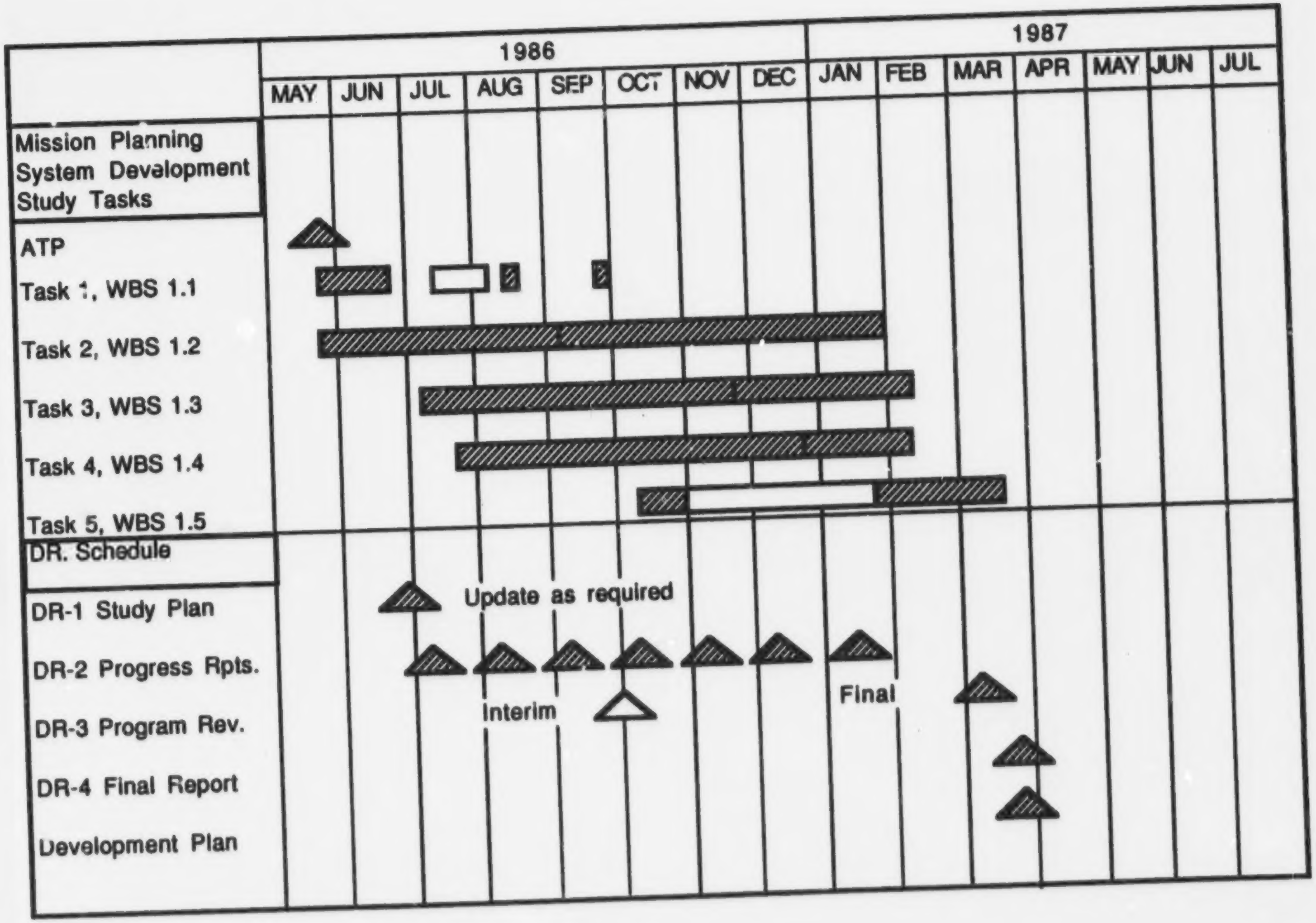


FIGURE 3-1. SS MPS DEVELOPMENT STUDY SCHEDULE

Section 4

TASK 1 - ORIENTATION

Task 1 activities first included orientation meetings with MSFC from 30 May 1986 through early June 1988. These orientation meetings primarily consisted of MSFC briefings and demonstrations of the Spacelab payload mission planning process and software and a tour of the MSFC Payload Operations Control Center (POCC). The knowledge gained from these meetings, plus handout materials and reference documents, equipped the Study team to commence its activities on Task 2. Of no less significance, these meetings permitted the establishment of working relationships with MSFC mission planning personnel whose inputs to all subsequent Study tasks were invaluable.

Task 1 activities also included MSFC briefings on 9 July 1986. These briefings provided the study team MSFC concepts and considerations as inputs to development of the Space Station mission planning concept in Task 3.

Final Task 1 activities consisted of travel to other NASA centers to investigate mission planning methods and tools (including AI applications) in use or under development at those centers, especially methods/tools oriented toward Space Station. On 13-15 August 1986, a trip to Johnson Space Center was accomplished. Subsequently, on 30 September through 2 October 1986, a trip to Ames Research Center and the Jet Propulsion Laboratory was accomplished. Appropriate reference documents and key contacts on the Space Station Program were obtained at JSC as subsequent reference sources for Task 3. Both trips provided information and contacts on potentially applicable AI concepts and technologies for Task 4.

Section 5

TASK 2 - REVIEW SPACELAB MISSION PLANNING PROCESS AND SOFTWARE

5.1 ACTIVITIES AND ACCOMPLISHMENTS

As previously stated, the purpose of Task 2 was to review the current Spacelab (SL) payload mission planning process and software and to develop a complete definition and understanding of the process and Mission Integration Planning (software) System (MIPS). The approach taken to this task was first to develop an upper level Spacelab functional flow diagram, then to group the major activities from the overall diagram into major functional areas of activity (which tended to correspond to MSFC mission planning organizational elements), and, finally, for each functional area, to develop detailed flows to a level sufficient to acquire a thorough understanding of the mission planning activities and to be able to correlate the capability of a SL MIPS software module to the objective of a specific activity. Based on knowledge gained, a data base of mission planning activities, activity descriptions, and resource data was also developed.

The major inputs to the task were MSFC briefings, demonstrations and handout materials, Spacelab mission planning process and software documentation, and personal interviews with Spacelab mission planning personnel. By far the most valuable of these inputs were the interviews/working sessions with mission planning personnel for development of the upper level functional flow and detailed flows. Mission planning personnel also made certain inputs to the data base which could only be provided by people who were experienced in the SL mission planning process. The support of these NASA personnel was essential in accomplishing this task.

The major products of this task were the Spacelab mission planning process functional flow diagrams and data base. These products, and the knowledge gained from their development, served as a significant input to Task 3, because they identified not only the SL Payload MIPS software modules of potential applicability to Space Station, but also a detailed understanding of the scope, nature, and sequence of activities and inputs/outputs that are required for the planning of payload on-orbit operations in general.

Finally, this task revealed certain characteristics and lessons learned from Spacelab payload mission planning that served as important considerations in the establishment of the fundamental objectives and approach toward Space Station mission planning in Task 3. These characteristics and lessons learned are presented below:

- Spacelab mission planning activities are centralized.
- Payload activities are scheduled down to the minute to make maximum utilization of resources during a short-duration mission.
- The collection of principal investigator experiment operations requirements is a very sizable manual effort which continues through all planning cycles.

- Spacelab mission planning employs a system of 58 actively used computer programs which have evolved over a ten-year period without the benefit of a rigidly controlled, structured process of development. (Upgrading of capabilities is still underway.)
- Though employing computer software, the Spacelab mission planning process involves considerable manual effort of highly skilled personnel.
- User-friendly interactive and automated software is considered of key importance to reducing mission planning manpower requirements.

5.2 SPACELAB MISSION PLANNING PROCESS

This subsection contains and provides introductory explanations of the Spacelab mission planning process functional flow diagrams and data base produced by Task 2 of the SS MPS Development Study. Together, the flow diagrams and data base constitute a complete and thorough definition of the sequence and nature of Spacelab mission planning process activities, and the associated Spacelab MIPS software capabilities and resource requirements.

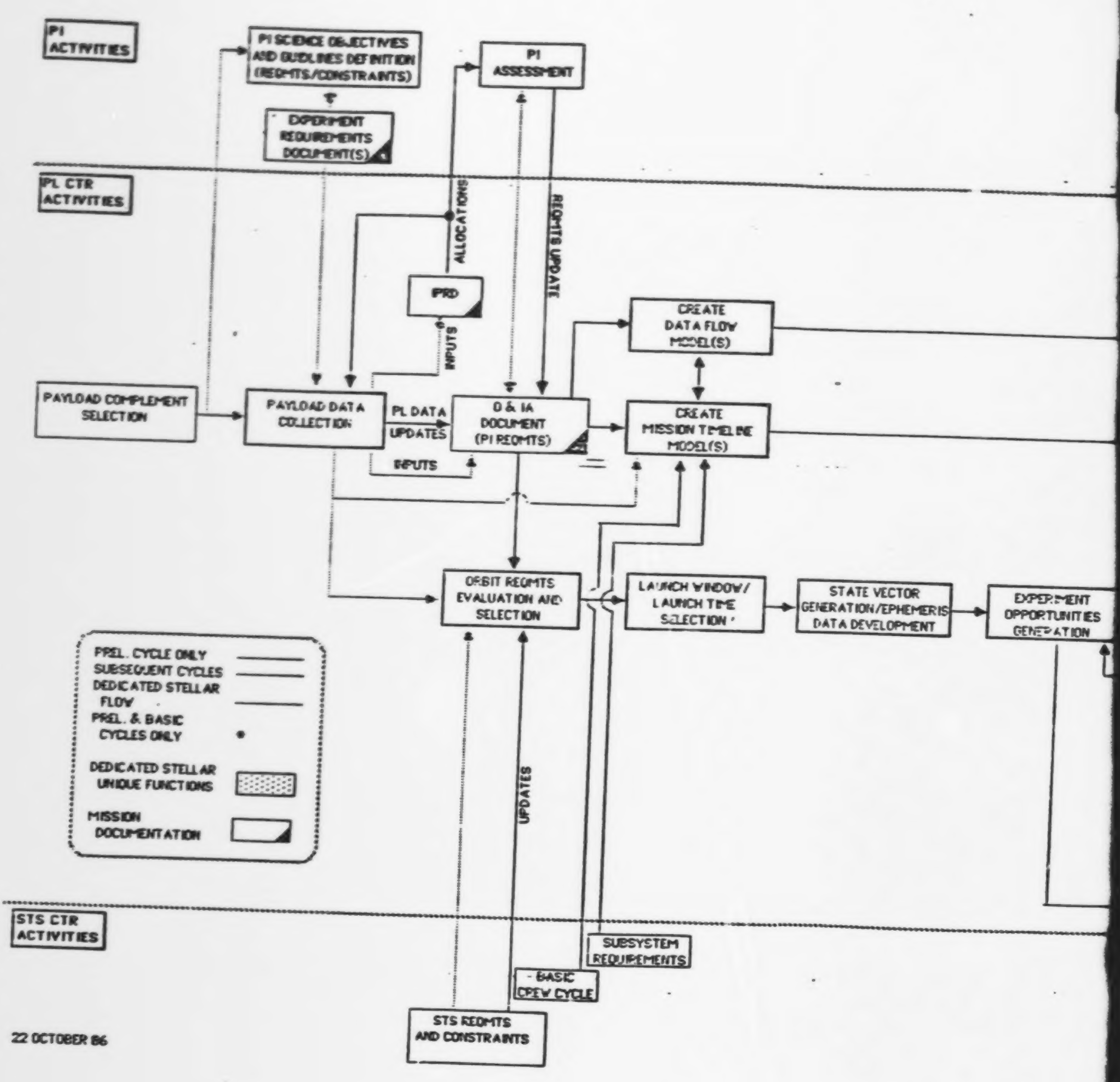
5.2.1 Spacelab Functional Flow

The Spacelab Functional Flow diagram, presented in Figure 5.2.1-1, was developed in order to identify all major activities of the Spacelab payload mission planning process. The diagram shows interfaces required by the planning center (MSFC) with the principal Investigators (PI's) and with the STS center (JSC). The PI interfaces are indicated at the top of the diagram and STS center interfaces are shown at the bottom of the diagram.

The Spacelab Functional Flow diagram includes activities ranging from payload data collection, through the required analyses, to preparation of payload mission execution documentation. The activities for three (3) planning cycles (preliminary, basic, update) are encompassed by the flow except where noted by the diagram legend. Real-time replanning activities are also encompassed by the flow. All activities may not be performed, or may be significantly reduced in a planning cycle based on the changes/updates required from a previous cycle. The flow accommodates a multidiscipline payload complement but includes a unique path for a payload complement of co-aligned IPS-mounted stellar observation experiments.

The SL mission planning process activities shown in the Spacelab Functional Flow diagram are grouped into nine (9) major functions. These functions and the subfunctions which comprise each are identified in Table 5.2.1-1.

Table 5.2.1-2 is a listing of acronyms and abbreviations used in the Spacelab Functional Flow diagram, and subsequently in the detailed flow diagrams and data base.

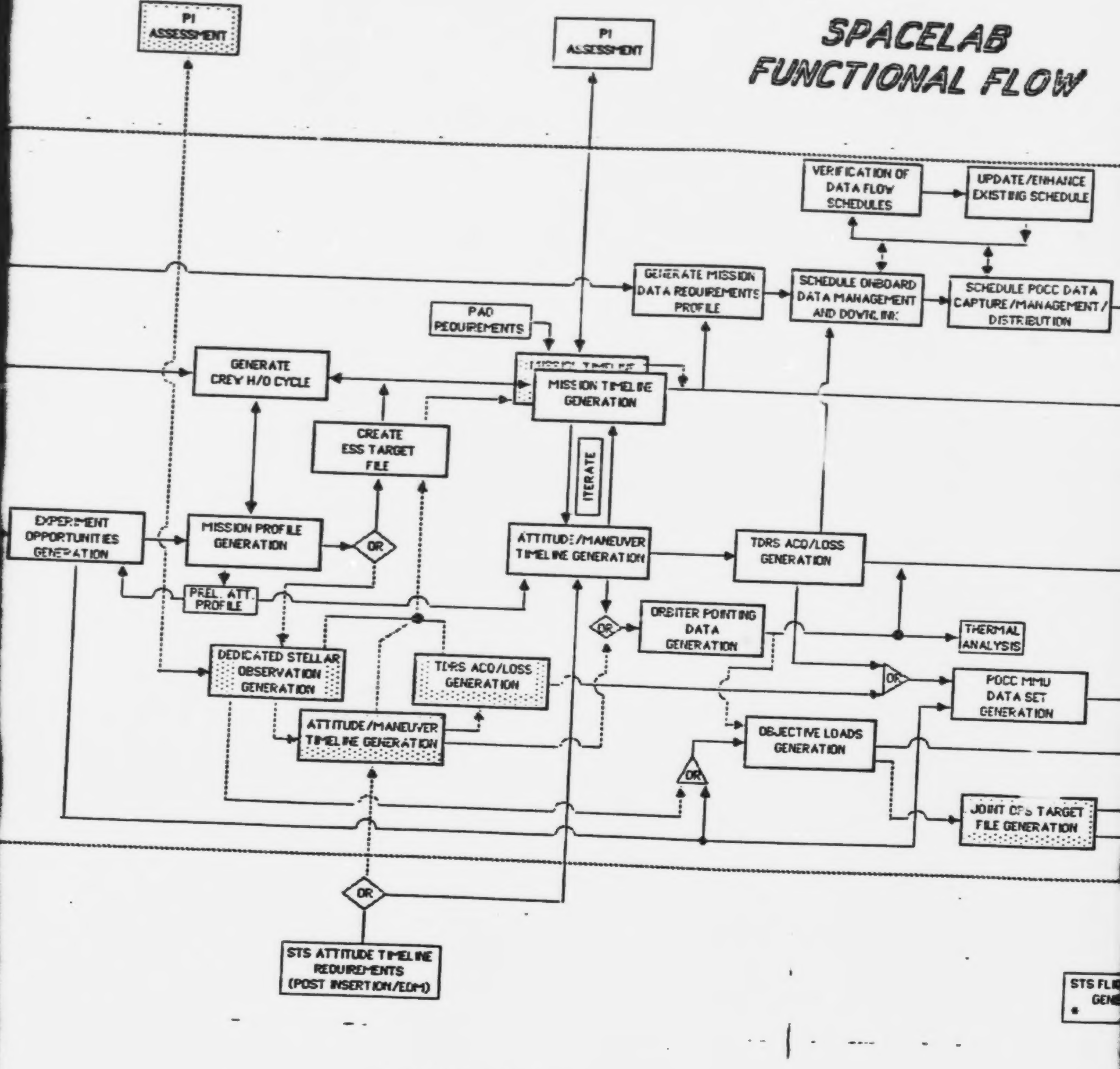

PI ACTIVITIES
PI SCIENCE OBJECTIVES AND GUIDELINES DEFINITION (REQMTS/CONSTRAINTS)
EXPERIMENT REQUIREMENTS DOCUMENT(S)
PI ASSESSMENT
PL CTR ACTIVITIES
ALLOCATIONS
REQMTS UPDATE
IPRD
INPUTS
CREATE DATA FLOW MODEL(S)
PAYLOAD COMPLEMENT SELECTION
PAYLOAD DATA COLLECTION
PL DATA UPDATES
D & IA DOCUMENT (PI REQMTS)
CREATE MISSION TIMELINE MODEL(S)
INPUTS
ORBIT REQMTS EVALUATION AND SELECTION
LAUNCH WINDOW/ LAUNCH TIME SELECTION *
STATE VECTOR GENERATION/EPHEMERIS DATA DEVELOPMENT
EXPERIMENT OPPORTUNITIES GENERATION
PREL. CYCLE ONLY
SUBSEQUENT CYCLES
DEDICATED STELLAR FLOW
PREL. & BASIC CYCLES ONLY *
DEDICATED STELLAR UNIQUE FUNCTIONS
MISSION DOCUMENTATION
UPDATES
STS CTR ACTIVITIES
SUBSYSTEM REQUIREMENTS
- BASIC CREW CYCLE
STS REQMTS AND CONSTRAINTS

22 OCTOBER 86

FOLDOUT FRAME

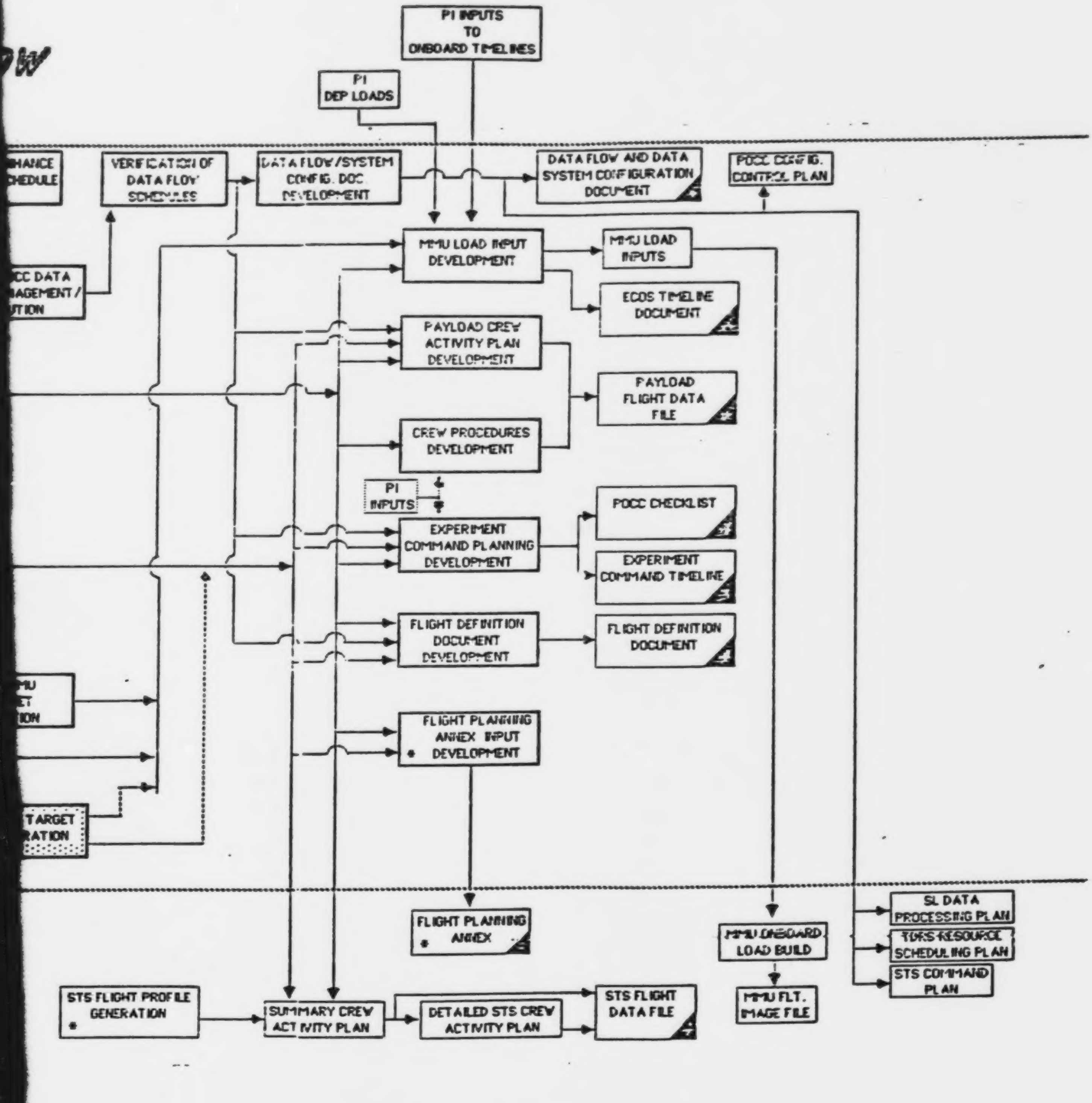
FIGURE 5.2.1-1.

SPACELAB FUNCTIONAL FLOW


PI ASSESSMENT
PI ASSESSMENT
VERIFICATION OF DATA FLOW SCHEDULES
UPDATE/ENHANCE EXISTING SCHEDULE
GENERATE MISSION DATA REQUIREMENTS PROFILE
SCHEDULE ONBOARD DATA MANAGEMENT AND DOWNLINK
SCHEDULE POCC DATA CAPTURE/MANAGEMENT/DISTRIBUTION
PAO REQUIREMENTS
GENERATE CREW H/O CYCLE
MISSION TIMELINE
MISSION TIMELINE GENERATION
CREATE ESS TARGET FILE
ITERATE
EXPERIMENT OPPORTUNITIES GENERATION
MISSION PROFILE GENERATION
OR
ATTITUDE/MANEUVER TIMELINE GENERATION
TDRS ACQ/LOSS GENERATION
PREL. ATT. PROFILE
OR
ORBITER POINTING DATA GENERATION
THERMAL ANALYSIS
DEDICATED STELLAR OBSERVATION GENERATION
TDRS ACQ/LOSS GENERATION
OR
POCC MMU DATA SET GENERATION
ATTITUDE/MANEUVER TIMELINE GENERATION
OBJECTIVE LOADS GENERATION
OR
JOINT OPS TARGET FILE GENERATION
OR
STS ATTITUDE TIMELINE REQUIREMENTS (POST INSERTION/EOM)
STS FLI
GEN
*

2 FOLDOUT FRAME

OW


PI INPUTS TO ONBOARD TIMELINES
PI DEP LOADS
HANCE CHEDULE
VERIFICATION OF DATA FLOW SCHEDULES
DATA FLOW/SYSTEM CONFIG. DOC DEVELOPMENT
DATA FLOW AND DATA SYSTEM CONFIGURATION DOCUMENT
POCC CONFIG. CONTROL PLAN
CC DATA AGEMENT/ UTION
MMU LOAD INPUT DEVELOPMENT
MMU LOAD INPUTS
ECOS TIMELINE DOCUMENT
PAYLOAD CREW ACTIVITY PLAN DEVELOPMENT
PAYLOAD FLIGHT DATA FILE
CREW PROCEDURES DEVELOPMENT
PI INPUTS
EXPERIMENT COMMAND PLANNING DEVELOPMENT
POCC CHECKLIST
EXPERIMENT COMMAND TIMELINE
FLIGHT DEFINITION DOCUMENT DEVELOPMENT
FLIGHT DEFINITION DOCUMENT
MU ET TION
FLIGHT PLANNING ANNEX INPUT * DEVELOPMENT
TARGET RATION
FLIGHT PLANNING * ANNEX
MMU ONBOARD LOAD BUILD
MMU FLT. IMAGE FILE
SL DATA PROCESSING PLAN
TDRS RESOURCE SCHEDULING PLAN
STS COMMAND PLAN
STS FLIGHT PROFILE GENERATION *
SUMMARY CREW ACTIVITY PLAN
DETAILED STS CREW ACTIVITY PLAN
STS FLIGHT DATA FILE

3 FOLDOUT FRAME

TABLE 5.2.1-1
SPACELAB FUNCTIONAL FLOW ACTIVITY GROUPINGS

FUNCTION	SUBFUNCTIONS
Payload Data Collection	N/A
Orbit Analysis	Orbit Requirements Evaluation and Selection
	Launch Window/Launch Time Selection
	State Vector Generation/Ephemeris Data Development
	Experiment Opportunities Generation
	Mission Profile Generation
	Dedicated Stellar Observation Generation
	Attitude/Maneuver Timeline Generation (Multidiscipline)
	Attitude/Maneuver Timeline Generation (Dedicated Stellar)
	Orbiter Pointing Data Generation
	TDRS Acquisition/Loss Generation
	POCC MMU Data Set Generation
	Objective Loads Generation
	Joint Operations Target File Generation (Dedicated Stellar)
Mission Timeline Analysis	Create Mission Timeline Models
	Generate Crew Handover Cycle
	Create ESS Target File
	Mission Timeline Generation
	Payload Crew Activity Plan Development

TABLE 5.2.1-1
SPACELAB FUNCTIONAL FLOW ACTIVITY GROUPINGS (CONT'D)

FUNCTION	SUBFUNCTIONS
Flight Definition Document Development	N/A
Flight Planning Annex Input Development	N/A
Crew Procedures Development	* Develop Stowage Book
	* Develop TV, Photo Procedures
	* Develop Experiment Crew procedures
	* Develop Payload Systems Handbook
	* Develop CDMS Dictionary
	* Build PFDF Documents
Data Flow Analysis	Create Data Flow Models
	Generate Mission Data Requirements Profile
	Schedule Onboard Data Management and Downlink
	Schedule POCC Data Capture/Management/Distribution
	Verification of Data Flow Schedules
	Data Flow and System Configuration Document Development
	Update or Enhance Existing Schedules
MMU Load Input Development	* Create ECOS Subordinate Timelines
	* Create ECOS Master Timeline
	* Build ECOS Timeline Tape
	* MMU Optimization

* These subfunctions do not appear in the upper level functional flow but are defined in the detailed flow diagrams

TABLE 5.2.1-1
SPACELAB FUNCTIONAL FLOW ACTIVITY GROUPINGS (CONT'D)

FUNCTION	SUBFUNCTIONS
Experiment Command Planning Development	* Generate Command List * Check Command Syntax * Produce Command Timetags * Generate Command Timeline * Create POCC Checklist * Check Activity Syntax * Produce Activity Timetags * Generate POCC Checklist and Command Timeline

---

* These subfunctions do not appear in the upper level functional flow but are defined in the detailed flow diagrams

TABLE 5.2.1-2

ACRONYMS AND ABBREVATIONS

ACT/DEACT - Activation/Deactivation (Spacelab)
ASCII - American Standard Code For Information Interchange
AT PHY - Atmospheric Physics
CAP - Crew Activity Plan
CDMS - Command and Data Management Subsystem (Spacelab)
CEL - Celestial
CMNDS - Commands
COO - Coobservation (File)
DDU - Data Display Unit (Spacelab)
DEFN - Definition
DEP - Dedicated Experiment Processor
DFA - Data Flow Analyst
DS - Dedicated Stellar (Mission)
EBCDC - Extended Binary Coded Decimal
ECAS - Experiment Computer Applications Software (Spacelab)
ECOS - Experiment Computer Operating System (Spacelab)
ERD - Experiment Requirements Document
EDT - VAX Editor
ESS - Experiment Scheduling System
FDD - Flight Definition Document
FO's - Functional Objectives (Experiments)
FPA - Flight Planning Annex
H/O - Handover (Crew Handover Cycle)
HDRR - High Data Rate Recorder (Spacelab)
HEX - Hexidecimal
HRM - High Rate Multiplexer (Spacelab)
IPRD - Integrated Payload Requirements Document
IPS - Instrument Pointing Subsystem (Spacelab)
IWG - Investigators Working Group
JSC - Johnson Space Center
LDF - List Directed File
MDP'S - Mission Dependent Parameters
MGMT, MANGMT - Management
MMU - Mass Memory Unit
MMUM - Mass Memory Unit Manager
MPE - Mission Peculiar Equipment
MSFC - Marshall Space Flight Center
MSN - Mission
MSN IND - Mission Independent
MTL - Master Timeline
MVR - Maneuver
NDF - Name Directed File
O&IA - Operations and Integration Agreements
O/O - On/Off (File)
OCCULT - Occultation (Orbiter)
OPS - Operations
PAO - Public Affairs Office
PCAP - Payload Crew Activity Plan

TABLE 5.1.1-2

ACRONYMS AND ABBREVATIONS

PFDF	-	Payload Flight Data File
PI	-	Principal Investigator
PL PHY	-	Plasma Physics
PL, P/L	-	Payload
POCC	-	Payload Operations Control Center
POH	-	Payload Operations Handbook
PTS	-	Payload Timeline Summary
SAA	-	South Atlantic Anomaly
SCAS	-	Subsystem Computer Applications Software (Spacelab)
SCOS	-	Subsystem Computer Operating System (Spacelab)
SL	-	Spacelab
SOPG	-	Science Operations Planning Group
SPAH	-	Spacelab Payload Accommodations Handbook
STL	-	Subordinate Timeline
STO	-	Storage (File)
STS	-	Space Transportation System
T/L, TL	-	Timeline
TDRS	-	Tracking and Data Relay Satellite
VAX	-	Digital Equipment Corporation Computer

5.2.2 Detailed Flow Diagrams

The SL mission planning process detailed flows provide, as necessary, a breakdown of functions and/or subfunctions to a task/subtask level necessary to understand the mission planning activities, or to a level to correlate a particular software module to an activity. For example, "Payload Data Collection", which is a manual activity, is detailed at the function level, whereas the Orbital Analysis subfunction "Experiment Opportunities Generation" is broken down to tasks and subtasks - e.g., "Generate Solar Targets" (task) and "Generate Sun Rise/Set" (subtask).

Activities may be manual, automated, or a combination of manual and automated. Manual activities normally include the collection of information (verbal inputs, informal or formal documentation), the evaluation and assessment of this information, and the publication of the results (informal or formal documentation). However, some manual activities produce a computerized input for a subsequent activity - e.g., use of the VAX editor to create a computerized file for use by a software module in a subsequent automated activity.

Automated activities include a software module, based on some fixed algorithm, which reads a computerized input file(s) (fixed format), performs specific operations on the input data, and then outputs the results as either a computerized output file(s) or as a printout. Some automated activities require, or permit, manual inputs to the software module via a keyboard.

A legend for the detailed flows is presented in Figure 5.2.2-1 which shows the conventions utilized in their development. The set of flows which represent the breakdown of the upper level Spacelab Functional Flow diagram to lower level detailed flows (subfunctions, tasks, subtasks) is presented on page 5-12 through page 5-59.

5.2.3 SL MIPS Data Base

The SL MIPS data base was developed in order to provide activity summary data, software description and requirements data, and activity time and skill requirements data. The level of detail of the data base is consistent with the level of detail in the Spacelab mission planning process detailed flow diagrams; that is, entries exist in the data base corresponding to each lowest hierarchical level activity (function, subfunction, task or subtask) identified for every function in the flow diagrams. When assessed in conjunction with the detailed flows, the data base provides a comprehensive definition of the Spacelab payload mission planning process.

The data base consists of eight (8) interrelated tables of data:

- Activity Summary Data
- Activity Time and Skill Requirements
- Software Used by Activity
- Software Description
- Software Peripherals Required
- Activity Input/Outputs
- Computer Input/Output Summary
- Manual Input/Output Summary

The complete data base, including an introductory explanation of each table, is contained in Appendix A of this volume.

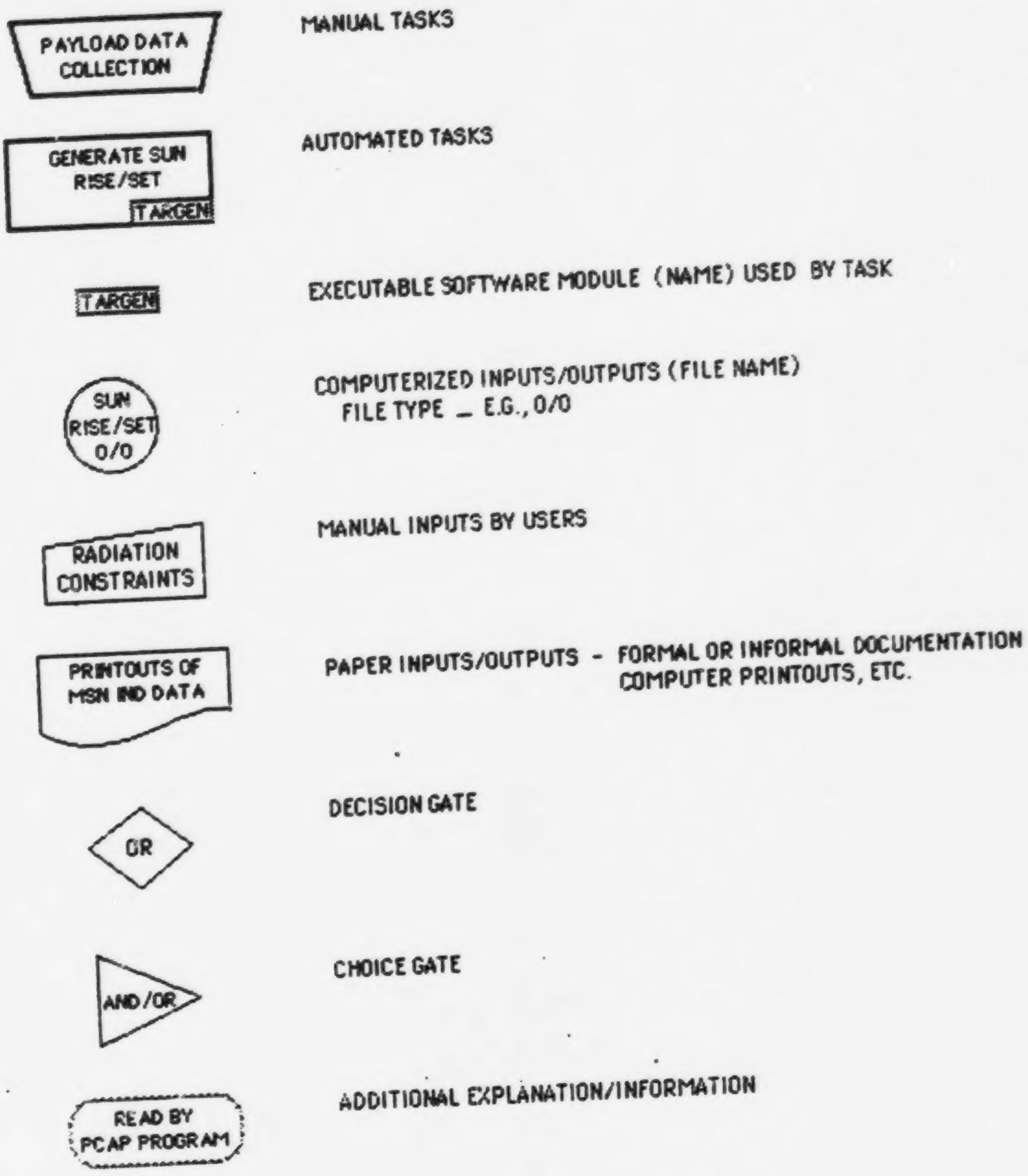
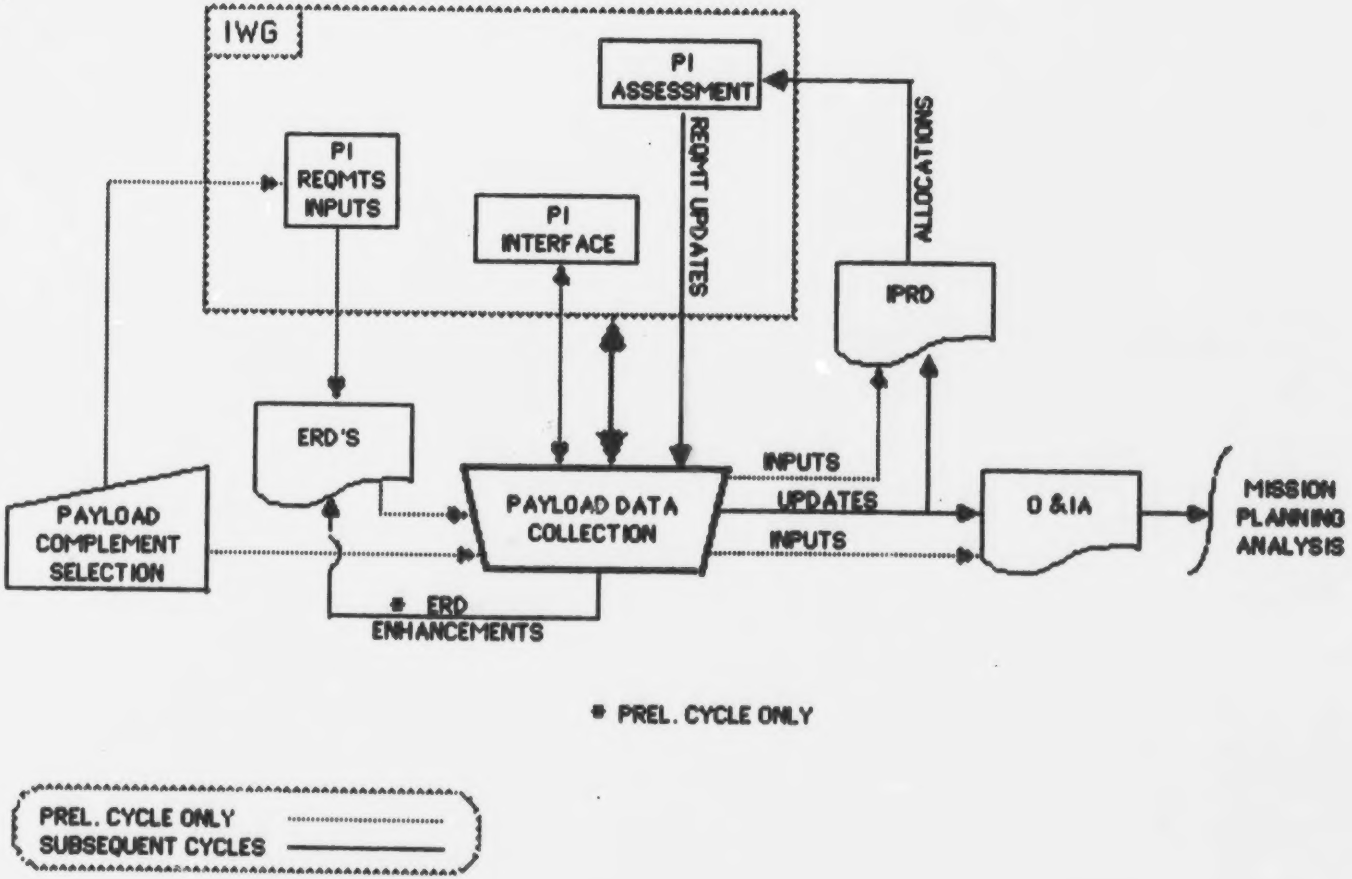
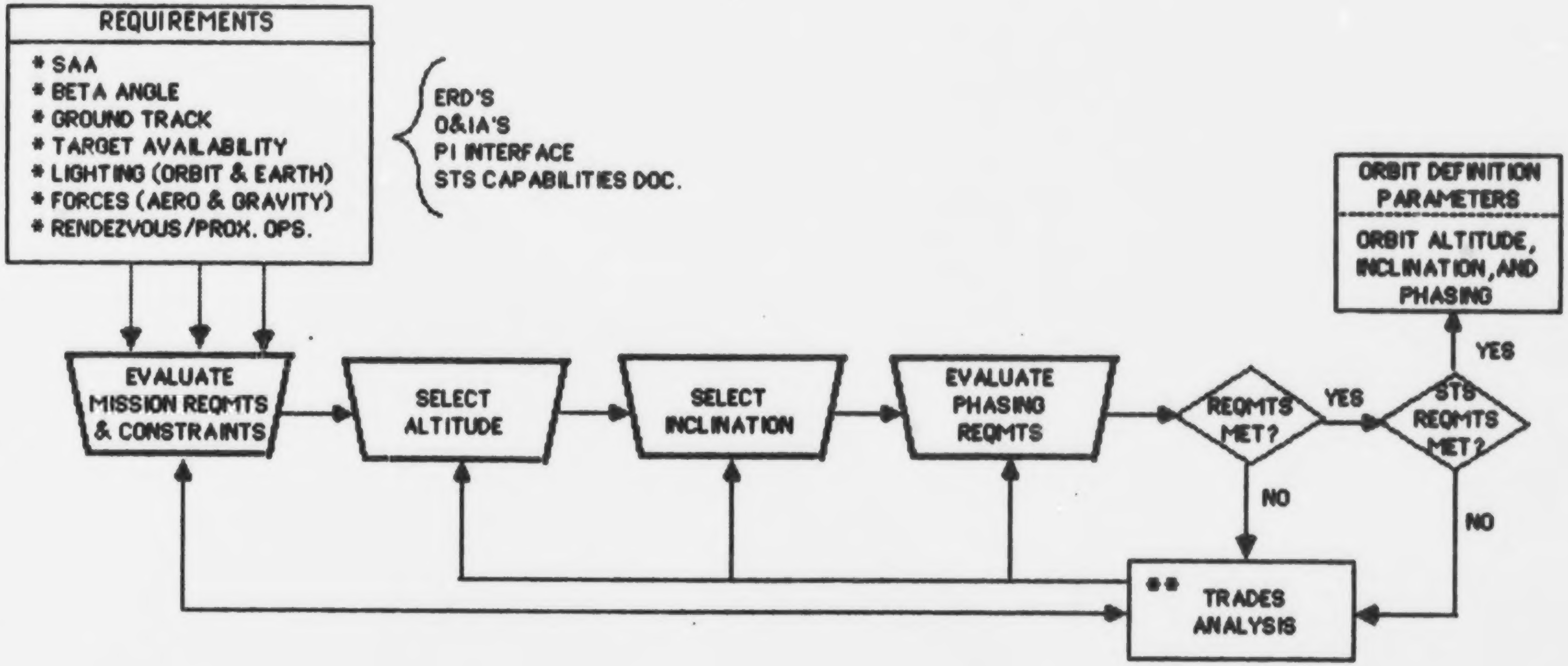

PAYLOAD DATA COLLECTION
MANUAL TASKS
GENERATE SUN RISE/SET
TARGEN
AUTOMATED TASKS
TARGEN
EXECUTABLE SOFTWARE MODULE (NAME) USED BY TASK
SUN RISE/SET 0/0
COMPUTERIZED INPUTS/OUTPUTS (FILE NAME)
FILE TYPE _ E.G., 0/0
RADIATION CONSTRAINTS
MANUAL INPUTS BY USERS
PRINTOUTS OF MSN IND DATA
PAPER INPUTS/OUTPUTS - FORMAL OR INFORMAL DOCUMENTATION COMPUTER PRINTOUTS, ETC.
OR
DECISION GATE
AND/OR
CHOICE GATE
READ BY PCAP PROGRAM
ADDITIONAL EXPLANATION/INFORMATION

FIGURE 5.2.2-1. SPACELAB FLOW DIAGRAM CONVENTIONS

FUNCTION: PAYLOAD DATA COLLECTION

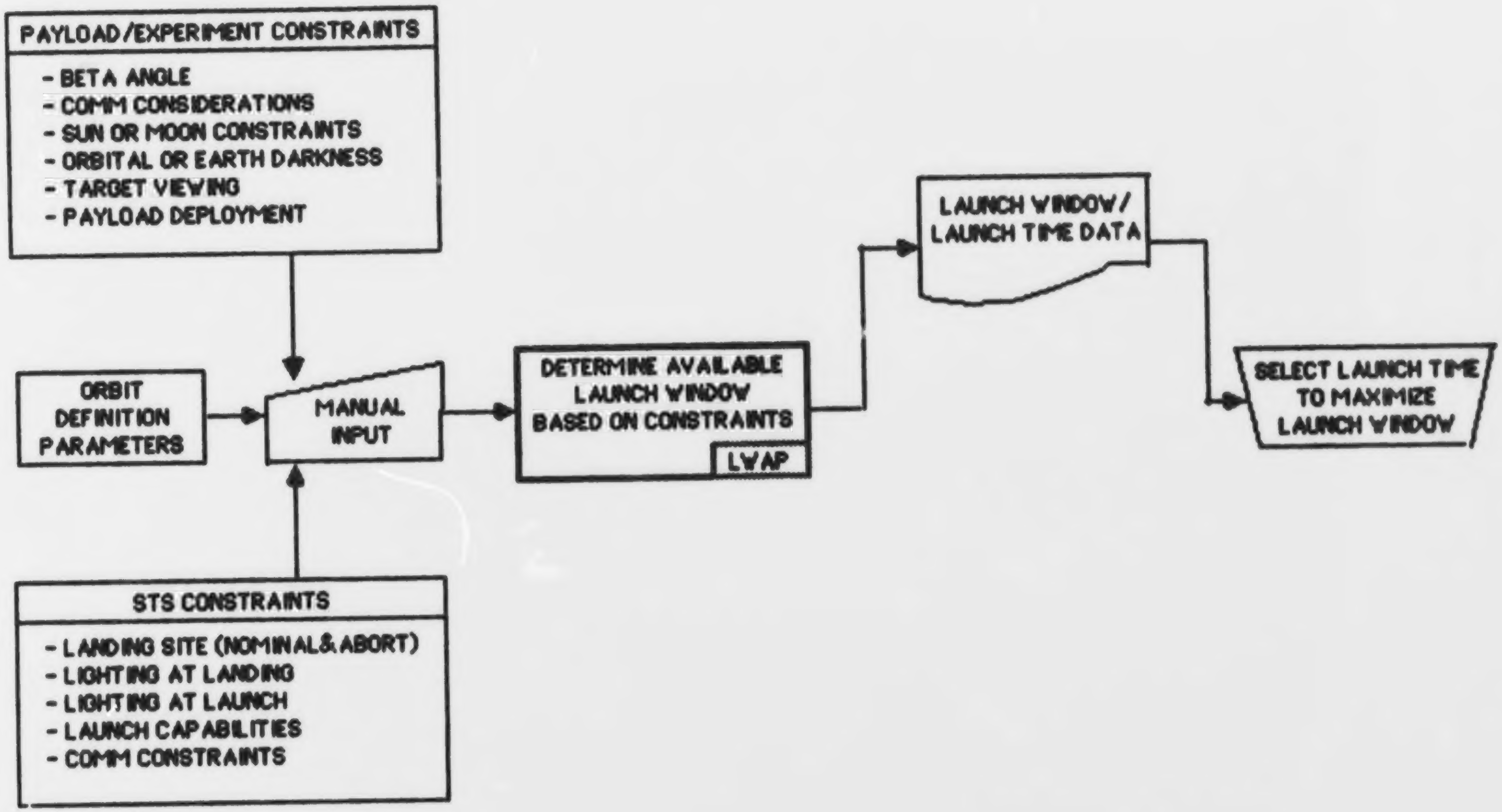

IWG
PI ASSESSMENT
PI REQMTS INPUTS
PI INTERFACE
REQMT UPDATES
ALLOCATIONS
IPRD
ERD'S
PAYLOAD COMPLEMENT SELECTION
PAYLOAD DATA COLLECTION
INPUTS
UPDATES
INPUTS
O &IA
MISSION PLANNING ANALYSIS
* ERD ENHANCEMENTS
* PREL. CYCLE ONLY
PREL. CYCLE ONLY
SUBSEQUENT CYCLES

FUNCTION: ORBITAL ANALYSIS
SUBFUNCTION: ORBIT REQUIREMENTS EVALUATION AND SELECTION

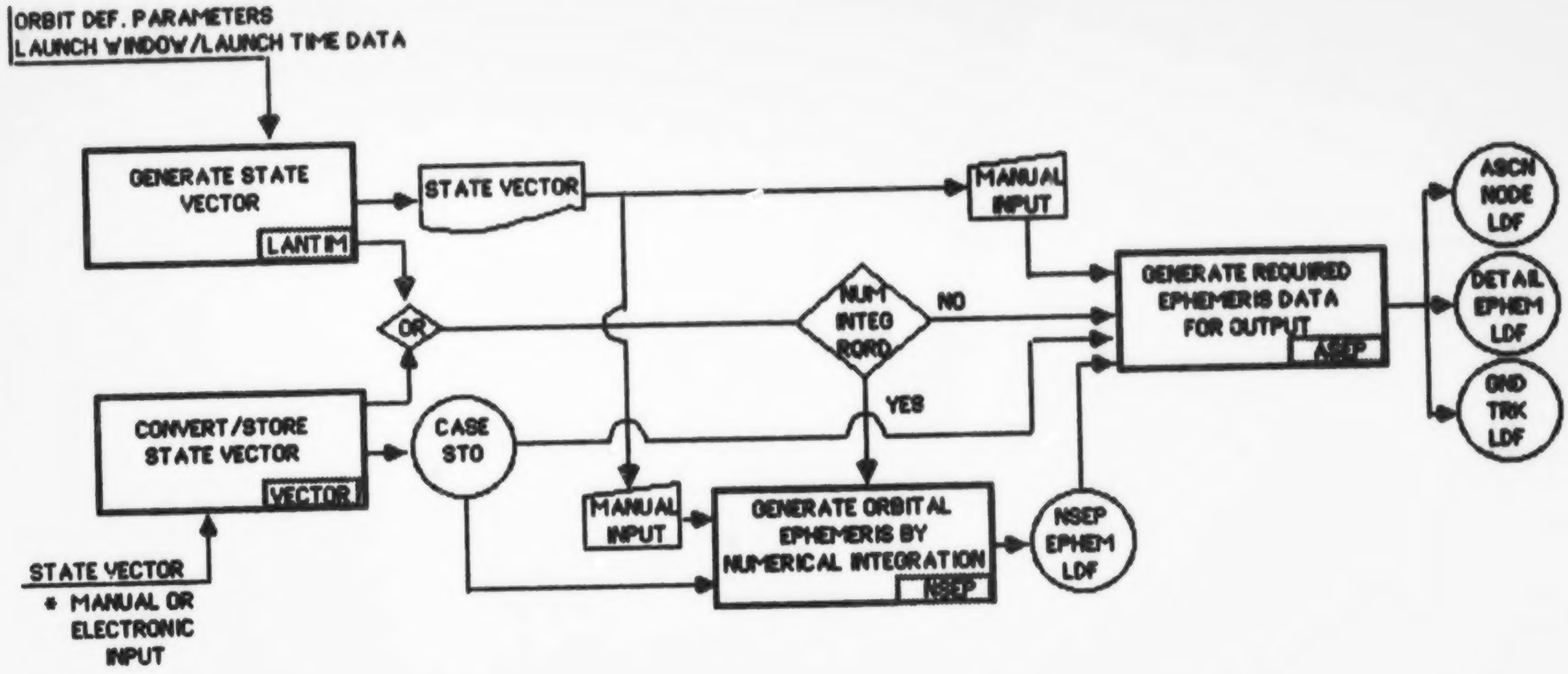

REQUIREMENTS
* SAA
* BETA ANGLE
* GROUND TRACK
* TARGET AVAILABILITY
* LIGHTING (ORBIT & EARTH)
* FORCES (AERO & GRAVITY)
* RENDEZVOUS/PROX. OPS.
ERD'S
O&IA'S
PI INTERFACE
STS CAPABILITIES DOC.
EVALUATE MISSION REQMTS & CONSTRAINTS
SELECT ALTITUDE
SELECT INCLINATION
EVALUATE PHASING REQMTS
REQMTS MET?
YES
NO
STS REQMTS MET?
YES
NO
ORBIT DEFINITION PARAMETERS
ORBIT ALTITUDE, INCLINATION, AND PHASING
** TRADES ANALYSIS

** THIS IS NORMALLY A MANUAL ACTIVITY. HOWEVER, IF A TRADES ANALYSIS IS REQUIRED THE FOLLOWING PROGRAMS MAY BE UTILIZED: ASEP/NSEP, ESAL, ESDATA, RADI2, BORB, OTHERS.

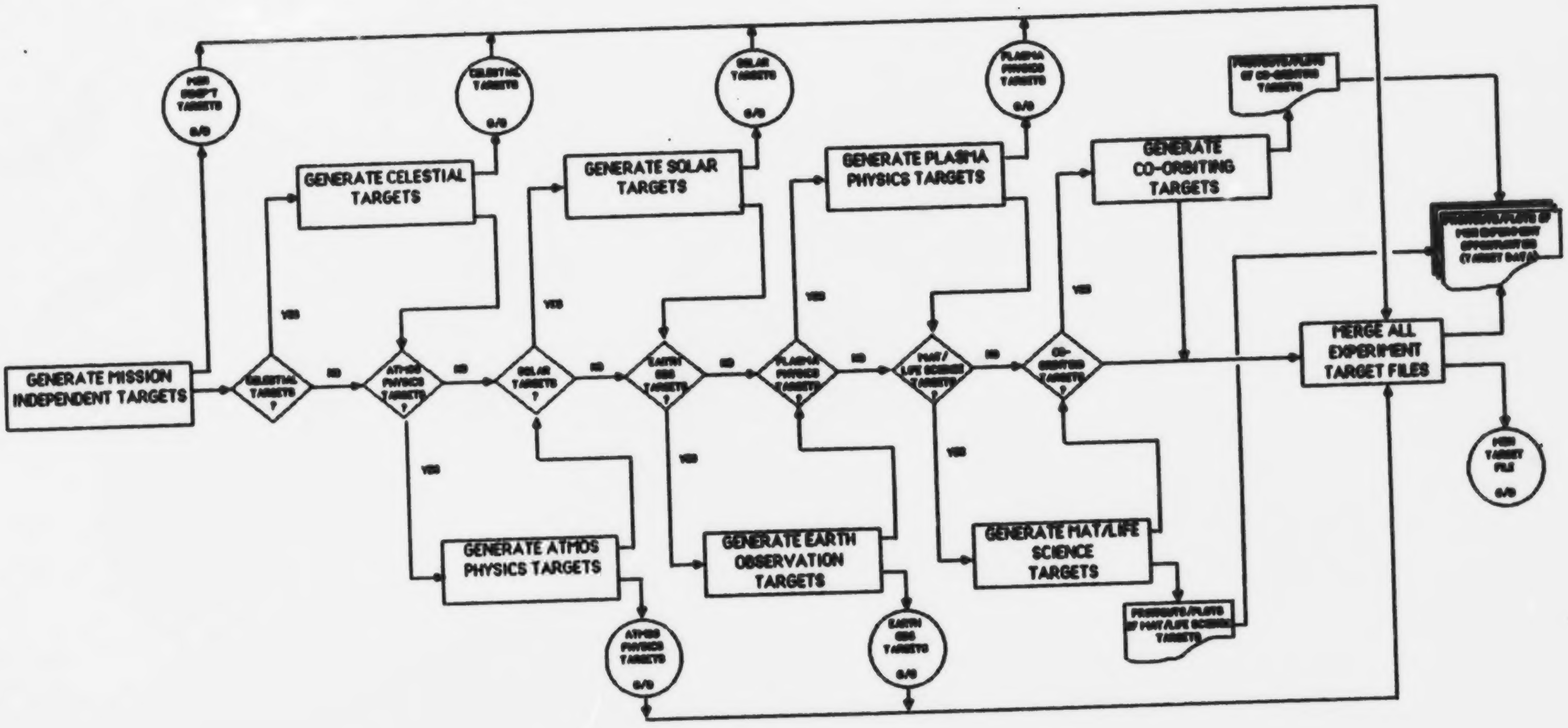
FUNCTION: ORBITAL ANALYSIS
SUBFUNCTION: LAUNCH WINDOW/LAUNCH TIME SELECTION


PAYLOAD/EXPERIMENT CONSTRAINTS
- BETA ANGLE
- COMM CONSIDERATIONS
- SUN OR MOON CONSTRAINTS
- ORBITAL OR EARTH DARKNESS
- TARGET VIEWING
- PAYLOAD DEPLOYMENT
ORBIT DEFINITION PARAMETERS
MANUAL INPUT
STS CONSTRAINTS
- LANDING SITE (NOMINAL & ABORT)
- LIGHTING AT LANDING
- LIGHTING AT LAUNCH
- LAUNCH CAPABILITIES
- COMM CONSTRAINTS
DETERMINE AVAILABLE LAUNCH WINDOW BASED ON CONSTRAINTS
LWAP
LAUNCH WINDOW/ LAUNCH TIME DATA
SELECT LAUNCH TIME TO MAXIMIZE LAUNCH WINDOW

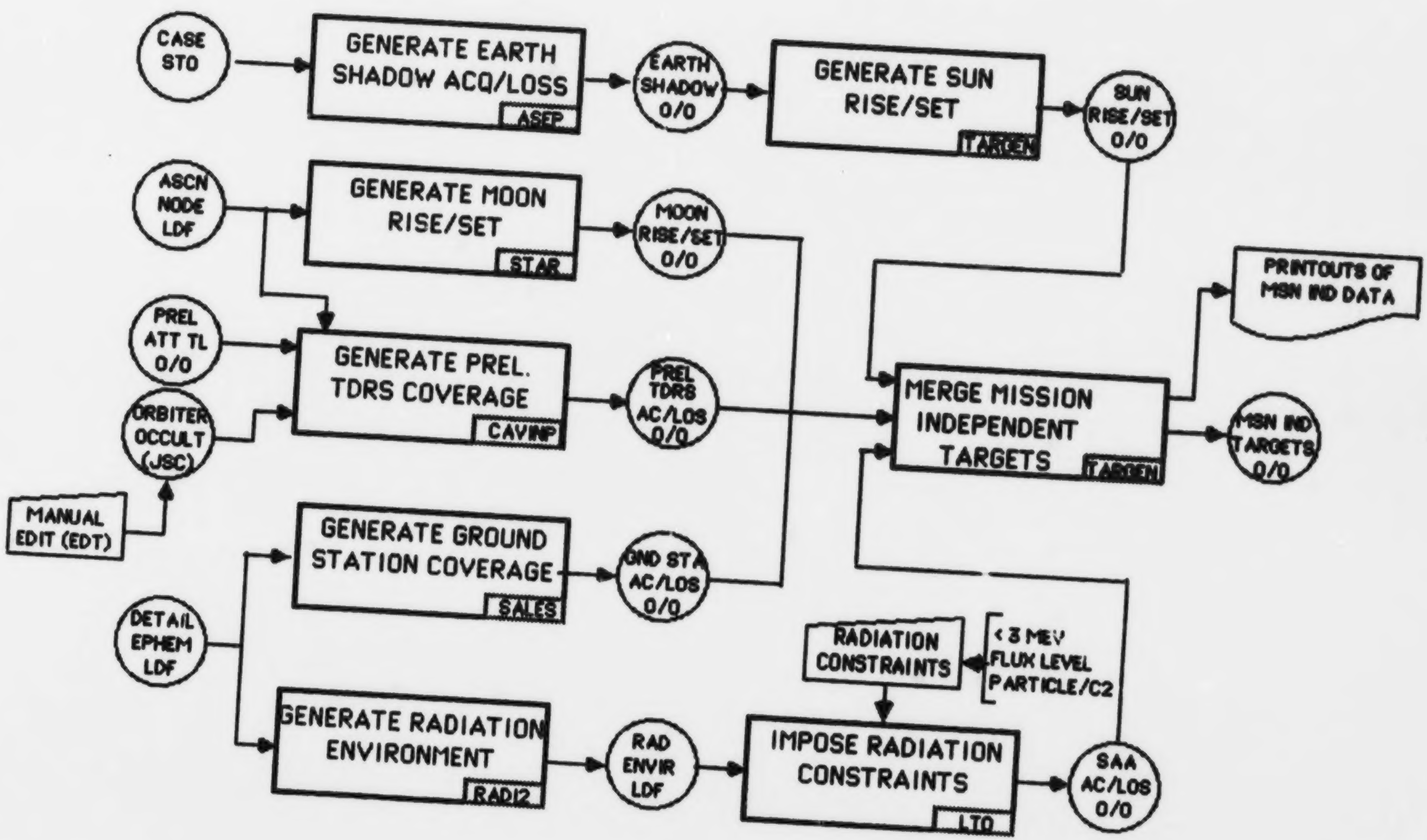
FUNCTION: ORBITAL ANALYSIS
SUBFUNCTION: STATE VECTOR GENERATION/EPHEMERIS DATA DEVELOPMENT


ORBIT DEF. PARAMETERS
LAUNCH WINDOW/LAUNCH TIME DATA
GENERATE STATE VECTOR
LANTIM
STATE VECTOR
MANUAL INPUT
OR
NUM INTEG RQRD
NO
YES
GENERATE REQUIRED EPHEMERIS DATA FOR OUTPUT
ASEP
ASCN NODE LDF
DETAIL EPHEM LDF
GND TRK LDF
CONVERT/STORE STATE VECTOR
VECTOR
CASE STO
MANUAL INPUT
GENERATE ORBITAL EPHEMERIS BY NUMERICAL INTEGRATION
NSEP
NSEP EPHEM LDF
STATE VECTOR
* MANUAL OR ELECTRONIC INPUT

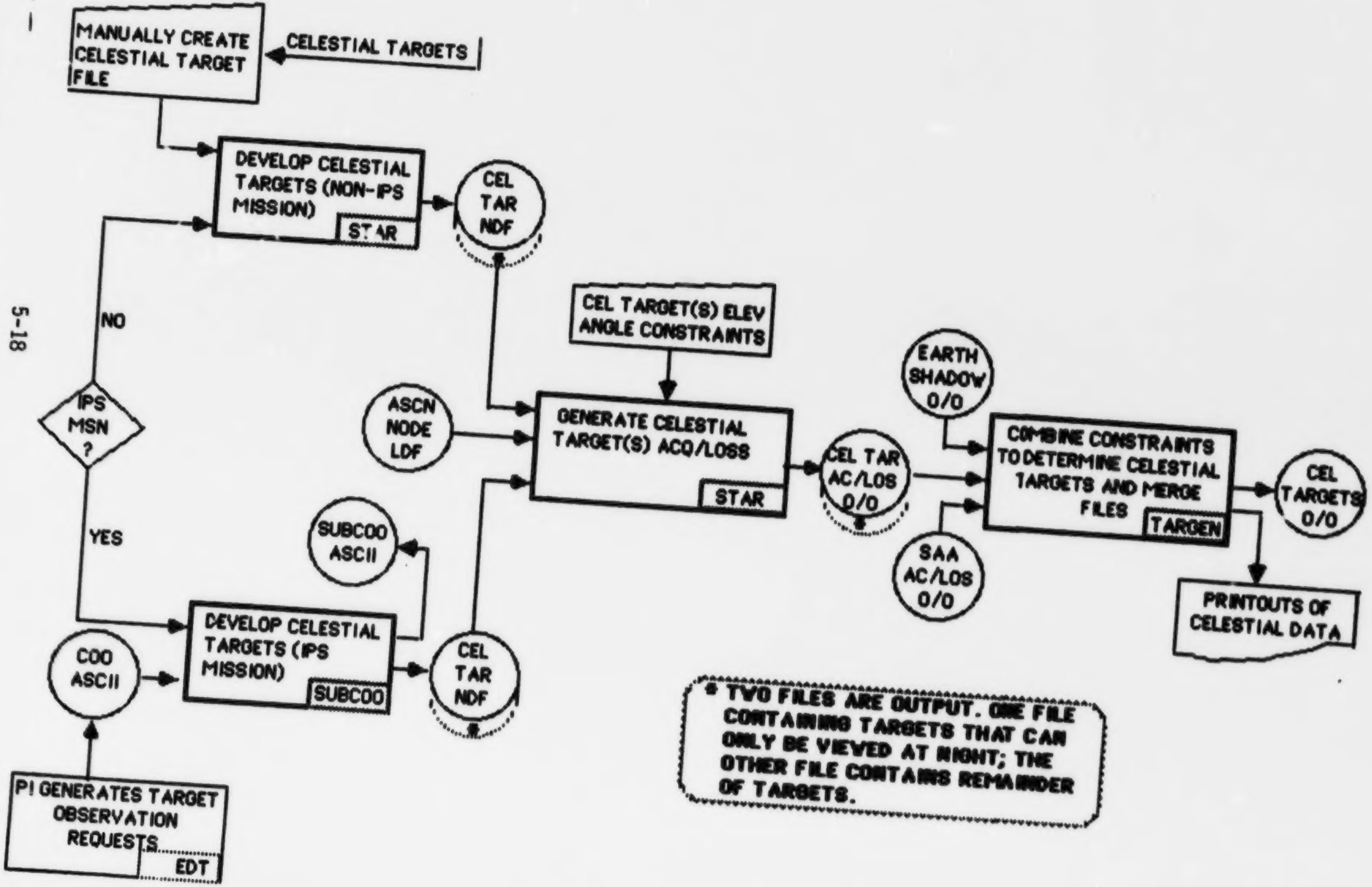
FUNCTION: ORBITAL ANALYSIS
SUBFUNCTION: EXPERIMENT OPPORTUNITIES GENERATION


GENERATE MISSION INDEPENDENT TARGETS
CELESTIAL TARGETS ?
YES
NO
GENERATE CELESTIAL TARGETS
CELESTIAL TARGETS
ATMOS PHYSICS TARGETS ?
GENERATE ATMOS PHYSICS TARGETS
SOLAR TARGETS ?
GENERATE SOLAR TARGETS
SOLAR TARGETS
EARTH OBS TARGETS ?
GENERATE EARTH OBSERVATION TARGETS
PLASMA PHYSICS TARGETS ?
GENERATE PLASMA PHYSICS TARGETS
PLASMA PHYSICS TARGETS
MAT/ LIFE SCIENCE TARGETS ?
GENERATE MAT/LIFE SCIENCE TARGETS
CO- ORBITING TARGETS ?
GENERATE CO-ORBITING TARGETS
MERGE ALL EXPERIMENT TARGET FILES
TARGET FILE

FUNCTION: ORBITAL ANALYSIS
SUBFUNCTION: EXPERIMENT OPPORTUNITIES GENERATION
TASK: GENERATE MISSION INDEPENDENT TARGETS

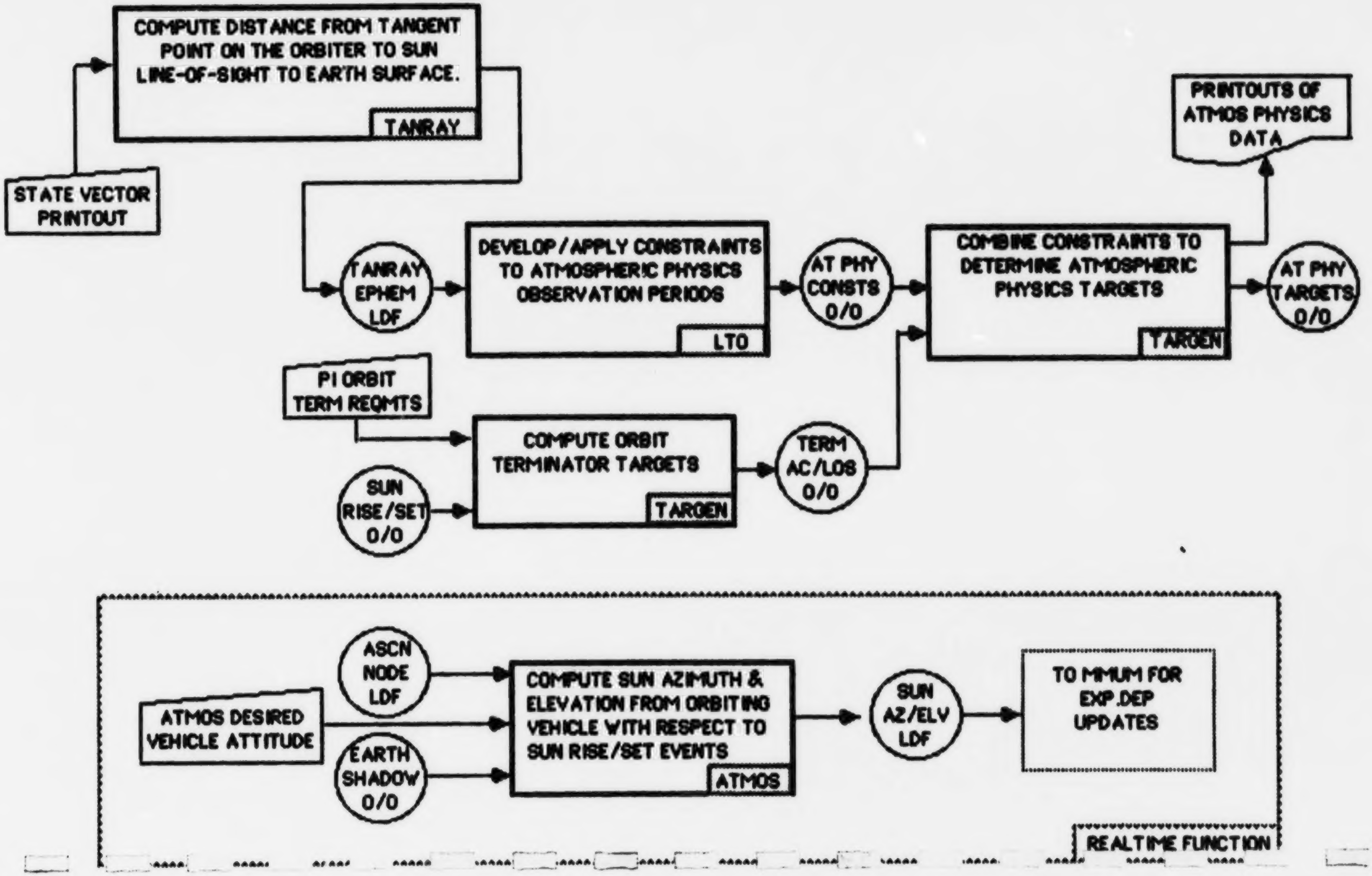

CASE STO
GENERATE EARTH SHADOW ACQ/LOSS
ASEP
EARTH SHADOW 0/0
GENERATE SUN RISE/SET
TARGEN
SUN RISE/SET 0/0
ASCN NODE LDF
GENERATE MOON RISE/SET
STAR
MOON RISE/SET 0/0
PREL ATT TL 0/0
ORBITER OCCULT (JSC)
MANUAL EDIT (EDT)
GENERATE PREL. TDRS COVERAGE
CAVINP
PREL TDRS AC/LOS 0/0
MERGE MISSION INDEPENDENT TARGETS
TARGEN
PRINTOUTS OF MSN IND DATA
MSN IND TARGETS 0/0
GENERATE GROUND STATION COVERAGE
SALES
GND STA AC/LOS 0/0
DETAIL EPHEM LDF
GENERATE RADIATION ENVIRONMENT
RADI2
RAD ENVIR LDF
RADIATION CONSTRAINTS
< 3 MEV FLUX LEVEL PARTICLE/C2
IMPOSE RADIATION CONSTRAINTS
LTO
SAA AC/LOS 0/0

FUNCTION: ORBITAL ANALYSIS
SUBFUNCTION: EXPERIMENT OPPORTUNITIES GENERATION
TASK: GENERATE CELESTIAL TARGETS

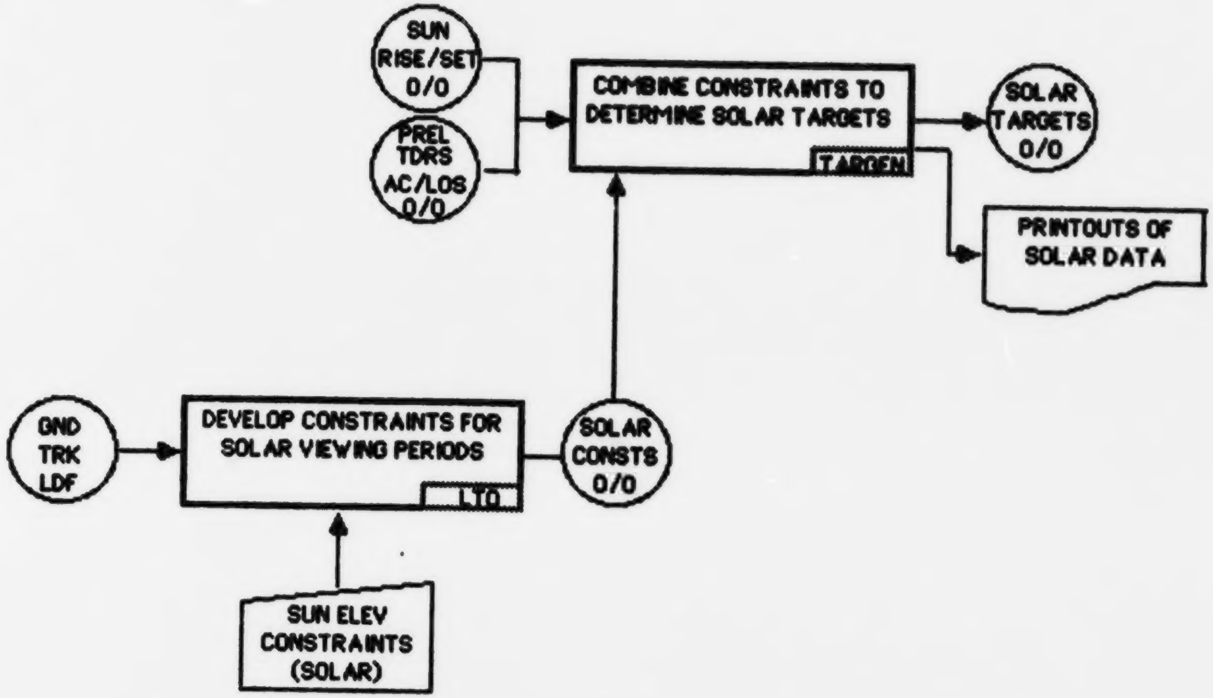

MANUALLY CREATE CELESTIAL TARGET FILE
CELESTIAL TARGETS
DEVELOP CELESTIAL TARGETS (NON-IPS MISSION)
STAR
CEL TAR NDF
NO
IPS MSN ?
YES
ASCN NODE LDF
CEL TARGET(S) ELEV ANGLE CONSTRAINTS
GENERATE CELESTIAL TARGET(S) ACQ/LOSS
STAR
CEL TAR AC/LOS 0/0
*
EARTH SHADOW 0/0
SAA AC/LOS 0/0
COMBINE CONSTRAINTS TO DETERMINE CELESTIAL TARGETS AND MERGE FILES
TARGEN
CEL TARGETS 0/0
PRINTOUTS OF CELESTIAL DATA
SUBCOO ASCII
DEVELOP CELESTIAL TARGETS (IPS MISSION)
SUBCOO
CEL TAR NDF
*
COO ASCII
PI GENERATES TARGET OBSERVATION REQUESTS
EDT

* TWO FILES ARE OUTPUT. ONE FILE CONTAINING TARGETS THAT CAN ONLY BE VIEWED AT NIGHT; THE OTHER FILE CONTAINS REMAINDER OF TARGETS.

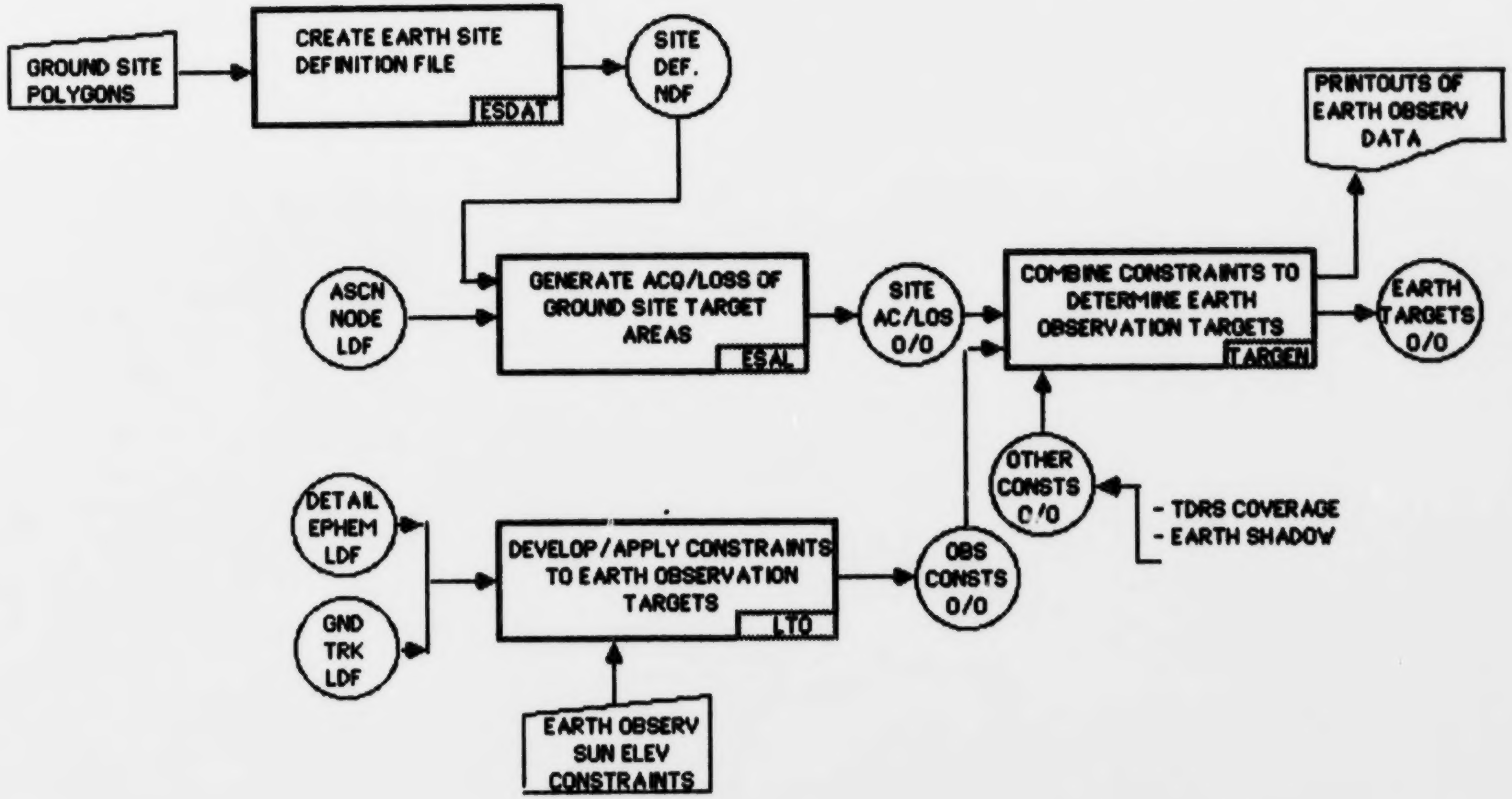
FUNCTION: ORBITAL ANALYSIS
SUBFUNCTION: EXPERIMENT OPPORTUNITIES GENERATION
TASK: GENERATE ATMOSPHERIC PHYSICS TARGETS


COMPUTE DISTANCE FROM TANGENT POINT ON THE ORBITER TO SUN LINE-OF-SIGHT TO EARTH SURFACE.
TANRAY
STATE VECTOR PRINTOUT
TANRAY EPHEM LDF
DEVELOP/APPLY CONSTRAINTS TO ATMOSPHERIC PHYSICS OBSERVATION PERIODS
LTO
AT PHY CONSTS 0/0
COMBINE CONSTRAINTS TO DETERMINE ATMOSPHERIC PHYSICS TARGETS
TARGEN
PRINTOUTS OF ATMOS PHYSICS DATA
AT PHY TARGETS 0/0
PI ORBIT TERM REQMTS
SUN RISE/SET 0/0
COMPUTE ORBIT TERMINATOR TARGETS
TARGEN
TERM AC/LOS 0/0
ASCN NODE LDF
ATMOS DESIRED VEHICLE ATTITUDE
EARTH SHADOW 0/0
COMPUTE SUN AZIMUTH & ELEVATION FROM ORBITING VEHICLE WITH RESPECT TO SUN RISE/SET EVENTS
ATMOS
SUN AZ/ELV LDF
TO MMUM FOR EXP.DEP UPDATES
REALTIME FUNCTION

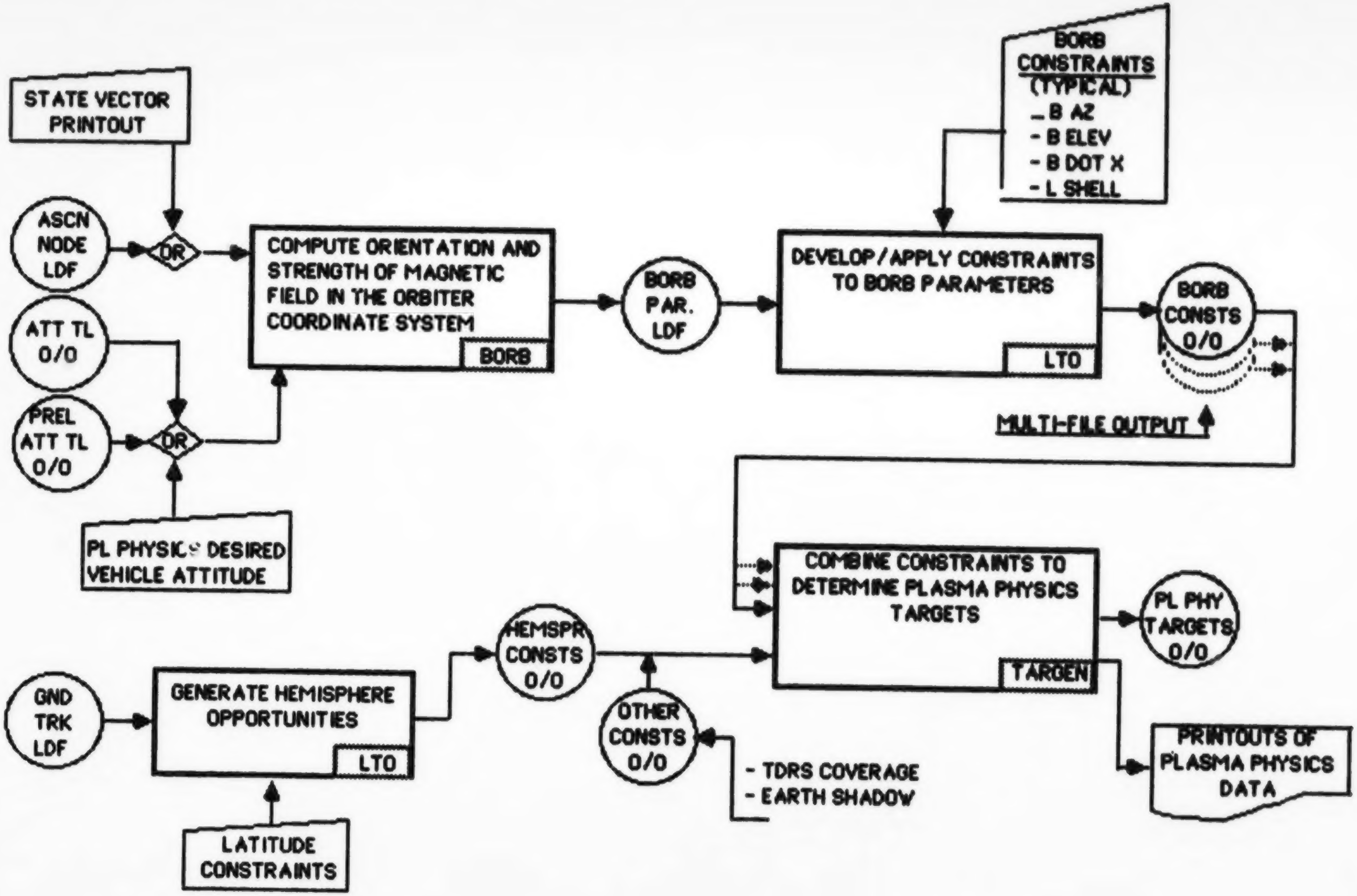
FUNCTION: ORBITAL ANALYSIS
SUBFUNCTION: EXPERIMENT OPPORTUNITIES GENERATION
TASK: GENERATE SOLAR TARGETS


SUN RISE/SET 0/0
PREL TDRS AC/LOS 0/0
COMBINE CONSTRAINTS TO DETERMINE SOLAR TARGETS
TARGEN
SOLAR TARGETS 0/0
PRINTOUTS OF SOLAR DATA
GND TRK LDF
DEVELOP CONSTRAINTS FOR SOLAR VIEWING PERIODS
LTO
SOLAR CONSTS 0/0
SUN ELEV CONSTRAINTS (SOLAR)

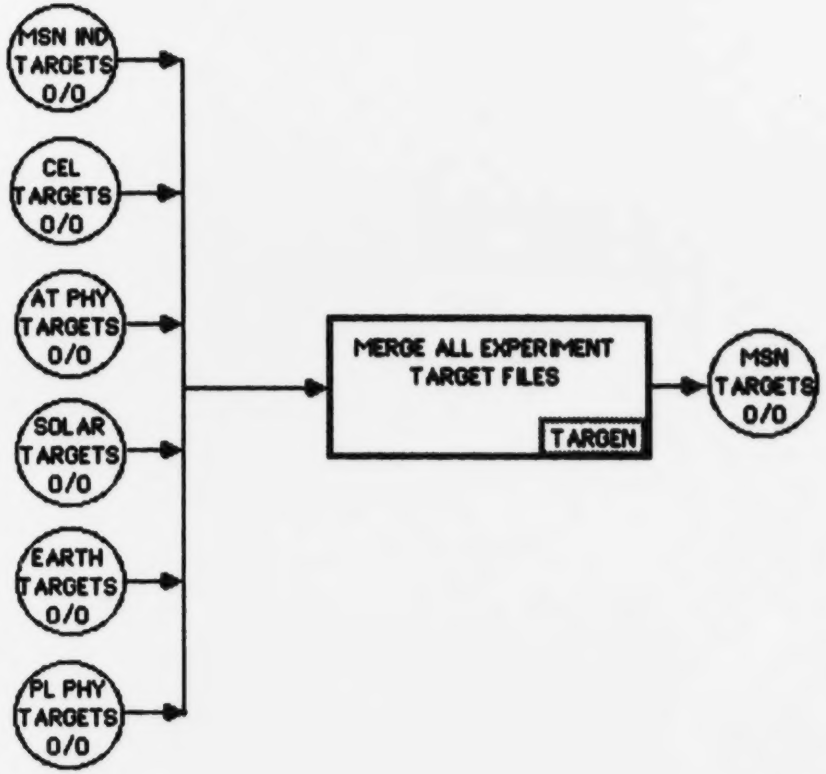
FUNCTION: ORBITAL ANALYSIS
SUBFUNCTION: EXPERIMENT OPPORTUNITIES GENERATION
TASK: GENERATE EARTH OBSERVATION TARGETS


GROUND SITE POLYGONS
CREATE EARTH SITE DEFINITION FILE
ESDAT
SITE DEF. NDF
ASCN NODE LDF
GENERATE ACQ/LOSS OF GROUND SITE TARGET AREAS
ESAL
SITE AC/LOS O/O
COMBINE CONSTRAINTS TO DETERMINE EARTH OBSERVATION TARGETS
TARGEN
PRINTOUTS OF EARTH OBSERV DATA
EARTH TARGETS O/O
DETAIL EPHEM LDF
GND TRK LDF
DEVELOP / APPLY CONSTRAINTS TO EARTH OBSERVATION TARGETS
LTO
EARTH OBSERV SUN ELEV CONSTRAINTS
OBS CONSTS O/O
OTHER CONSTS O/O
- TDRS COVERAGE
- EARTH SHADOW

FUNCTION: ORBITAL ANALYSIS
SUBFUNCTION: EXPERIMENT OPPORTUNITIES GENERATION
TASK: GENERATE PLASMA PHYSICS TARGETS


STATE VECTOR PRINTOUT
ASCN NODE LDF
OR
ATT TL 0/0
PREL ATT TL 0/0
OR
PL PHYSICS DESIRED VEHICLE ATTITUDE
COMPUTE ORIENTATION AND STRENGTH OF MAGNETIC FIELD IN THE ORBITER COORDINATE SYSTEM
BORB
BORB PAR. LDF
BORB CONSTRAINTS (TYPICAL)
- B AZ
- B ELEV
- B DOT X
- L SHELL
DEVELOP/APPLY CONSTRAINTS TO BORB PARAMETERS
LTO
BORB CONSTS 0/0
MULTI-FILE OUTPUT
GND TRK LDF
GENERATE HEMISPHERE OPPORTUNITIES
LTO
LATITUDE CONSTRAINTS
HEMSPR CONSTS 0/0
OTHER CONSTS 0/0
- TDRS COVERAGE
- EARTH SHADOW
COMBINE CONSTRAINTS TO DETERMINE PLASMA PHYSICS TARGETS
TARGEN
PL PHY TARGETS 0/0
PRINTOUTS OF PLASMA PHYSICS DATA

FUNCTION: ORBITAL ANALYSIS
SUBFUNCTION: EXPERIMENT OPPORTUNITIES GENERATION
TASK: MERGE ALL EXPERIMENT TARGET FILES

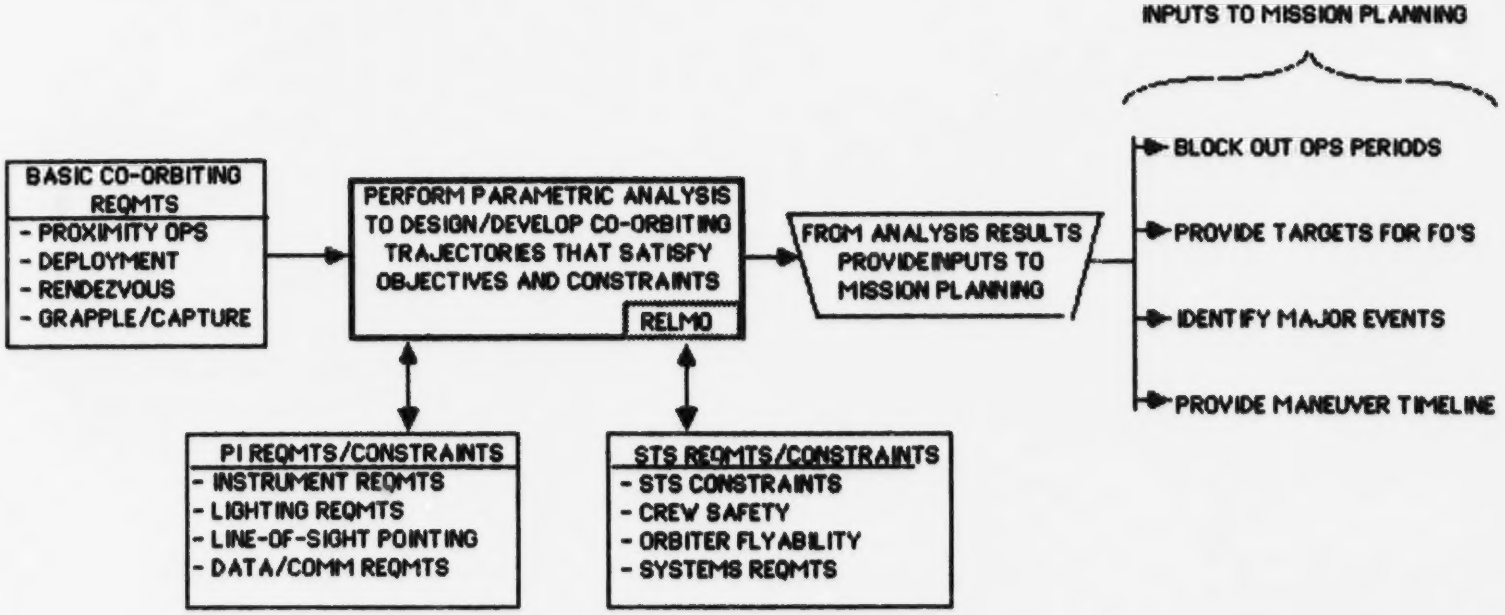

MSN IND TARGETS 0/0
CEL TARGETS 0/0
AT PHY TARGETS 0/0
SOLAR TARGETS 0/0
EARTH TARGETS 0/0
PL PHY TARGETS 0/0
MERGE ALL EXPERIMENT TARGET FILES
TARGEN
MSN TARGETS 0/0

FUNCTION: ORBITAL ANALYSIS
SUBFUNCTION: EXPERIMENT OPPORTUNITIES GENERATION
TASK: GENERATE MATERIAL AND/OR LIFE SCIENCE TARGETS

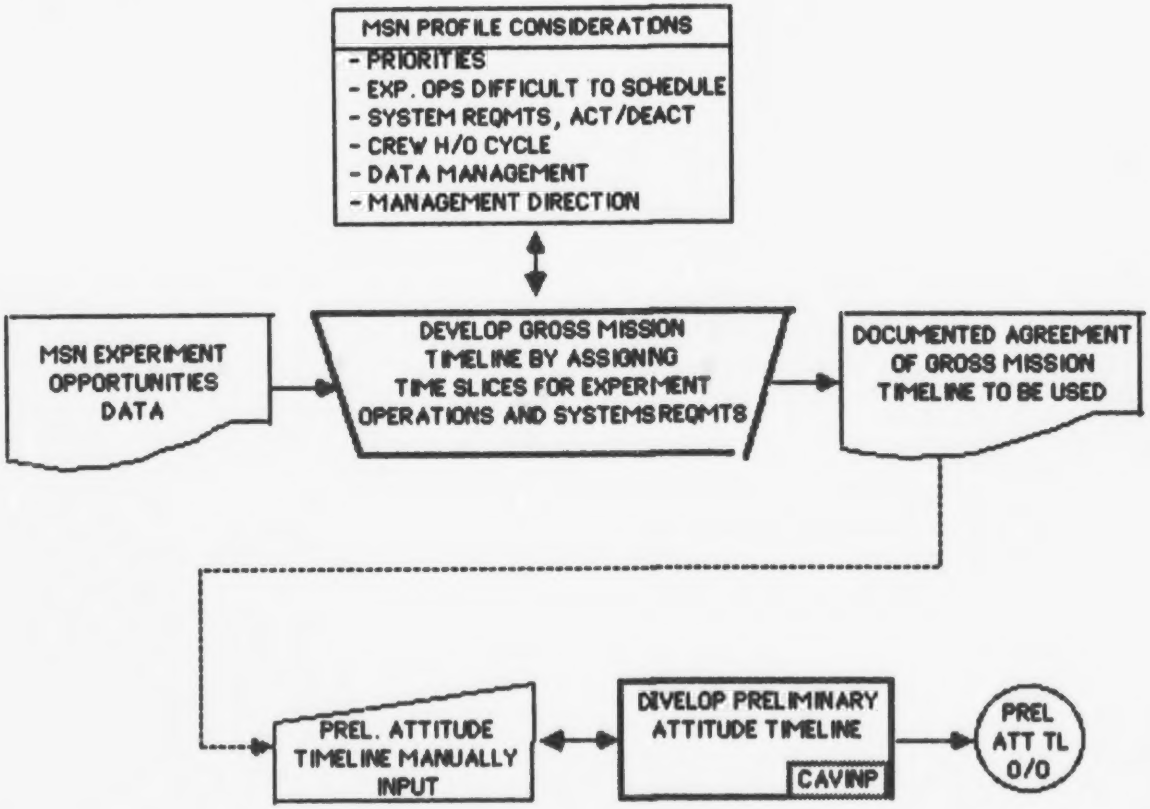
MATERIAL/LIFE SCIENCE TARGET PERIODS ARE DEVELOPED/ASSIGNED BASED ON EXPERIMENT OPERATIONS AND SYSTEMS REQUIREMENTS IN THE " MISSION PROFILE GENERATION " SUBFUCTION.

MISSION PLANNERS WOULD MAXIMIZE TDRS COVERAGE (WITHIN CONSTRAINTS) FOR EXPERIMENTS OF THIS TYPE. TDRS COVERAGE WILL BE DEVELOPED IN THE " ATTITUDE/MANEUVER TIMELINE GENERATION " SUBFUCTION IN CONJUCTION WITH THE " MISSION TIMELINE GENERATION " SUBFUNCTION.

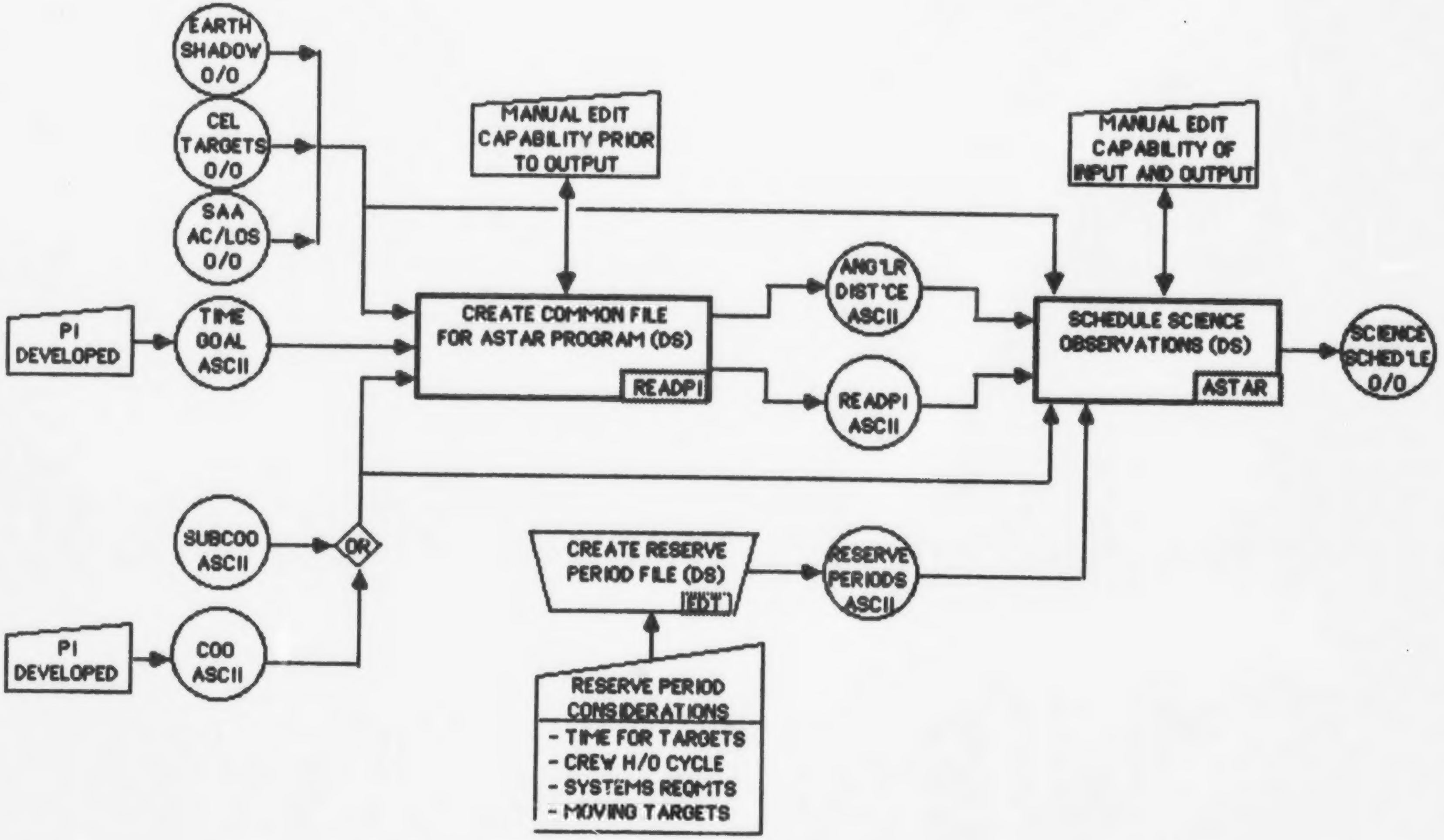
FUNCTION: ORBITAL ANALYSIS
SUBFUNCTION: EXPERIMENT OPPORTUNITIES GENERATION
TASK: GENERATE CO-ORBITING TARGETS


INPUTS TO MISSION PLANNING
BASIC CO-ORBITING REQMTS
- PROXIMITY OPS
- DEPLOYMENT
- RENDEZVOUS
- GRAPPLE/CAPTURE
PERFORM PARAMETRIC ANALYSIS TO DESIGN/DEVELOP CO-ORBITING TRAJECTORIES THAT SATISFY OBJECTIVES AND CONSTRAINTS
RELMO
FROM ANALYSIS RESULTS PROVIDEINPUTS TO MISSION PLANNING
BLOCK OUT OPS PERIODS
PROVIDE TARGETS FOR FO'S
IDENTIFY MAJOR EVENTS
PROVIDE MANEUVER TIMELINE
PI REQMTS/CONSTRAINTS
- INSTRUMENT REQMTS
- LIGHTING REQMTS
- LINE-OF-SIGHT POINTING
- DATA/COMM REQMTS
STS REQMTS/CONSTRAINTS
- STS CONSTRAINTS
- CREW SAFETY
- ORBITER FLYABILITY
- SYSTEMS REQMTS

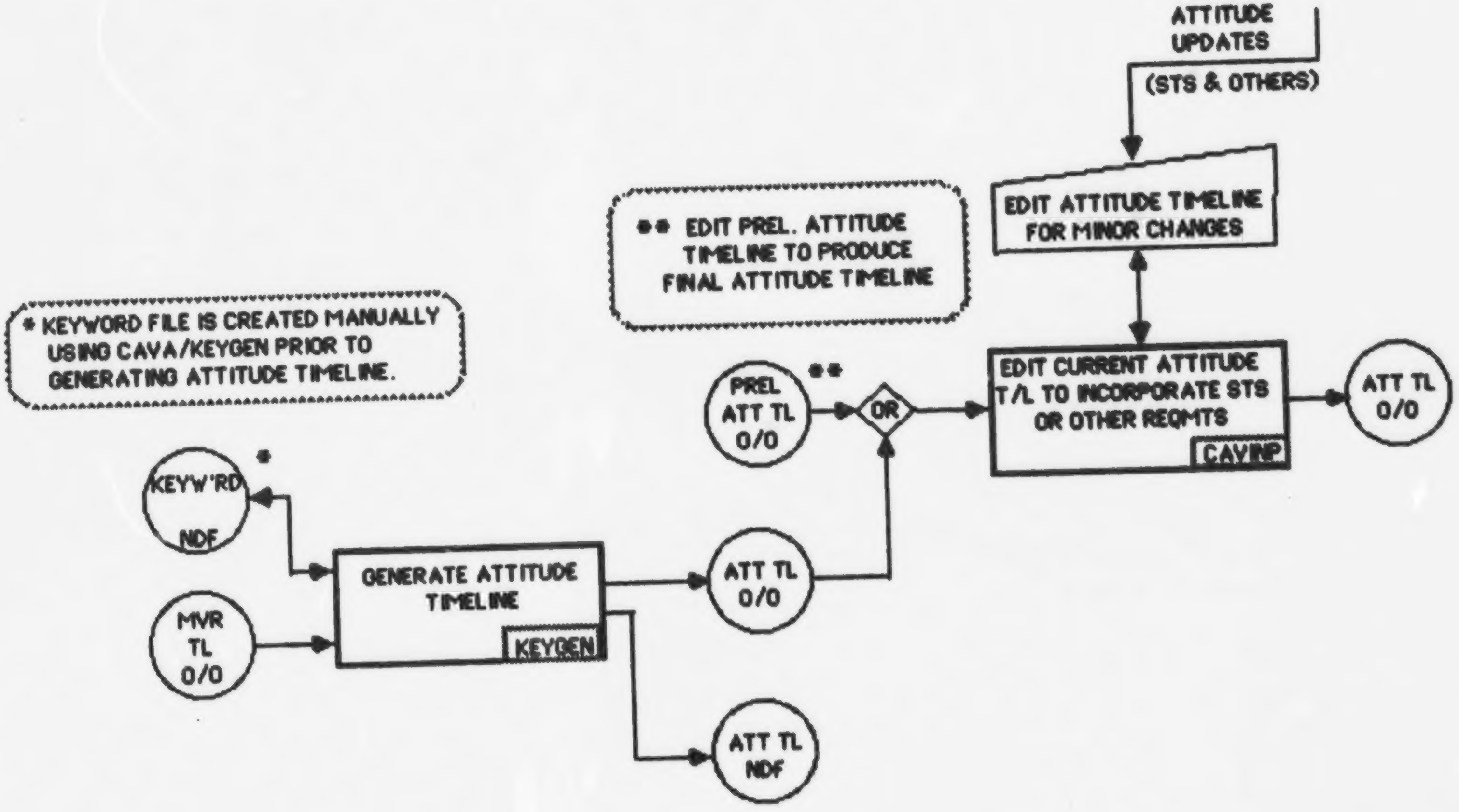
FUNCTION: ORBITAL ANALYSIS
SUBFUNCTION: MISSION PROFILE GENERATION


MSN PROFILE CONSIDERATIONS
- PRIORITIES
- EXP. OPS DIFFICULT TO SCHEDULE
- SYSTEM REQMTS, ACT/DEACT
- CREW H/O CYCLE
- DATA MANAGEMENT
- MANAGEMENT DIRECTION
MSN EXPERIMENT OPPORTUNITIES DATA
DEVELOP GROSS MISSION TIMELINE BY ASSIGNING TIME SLICES FOR EXPERIMENT OPERATIONS AND SYSTEMS REQMTS
DOCUMENTED AGREEMENT OF GROSS MISSION TIMELINE TO BE USED
PREL. ATTITUDE TIMELINE MANUALLY INPUT
DIVELOP PRELIMINARY ATTITUDE TIMELINE
CAVINP
PREL ATT TL O/O

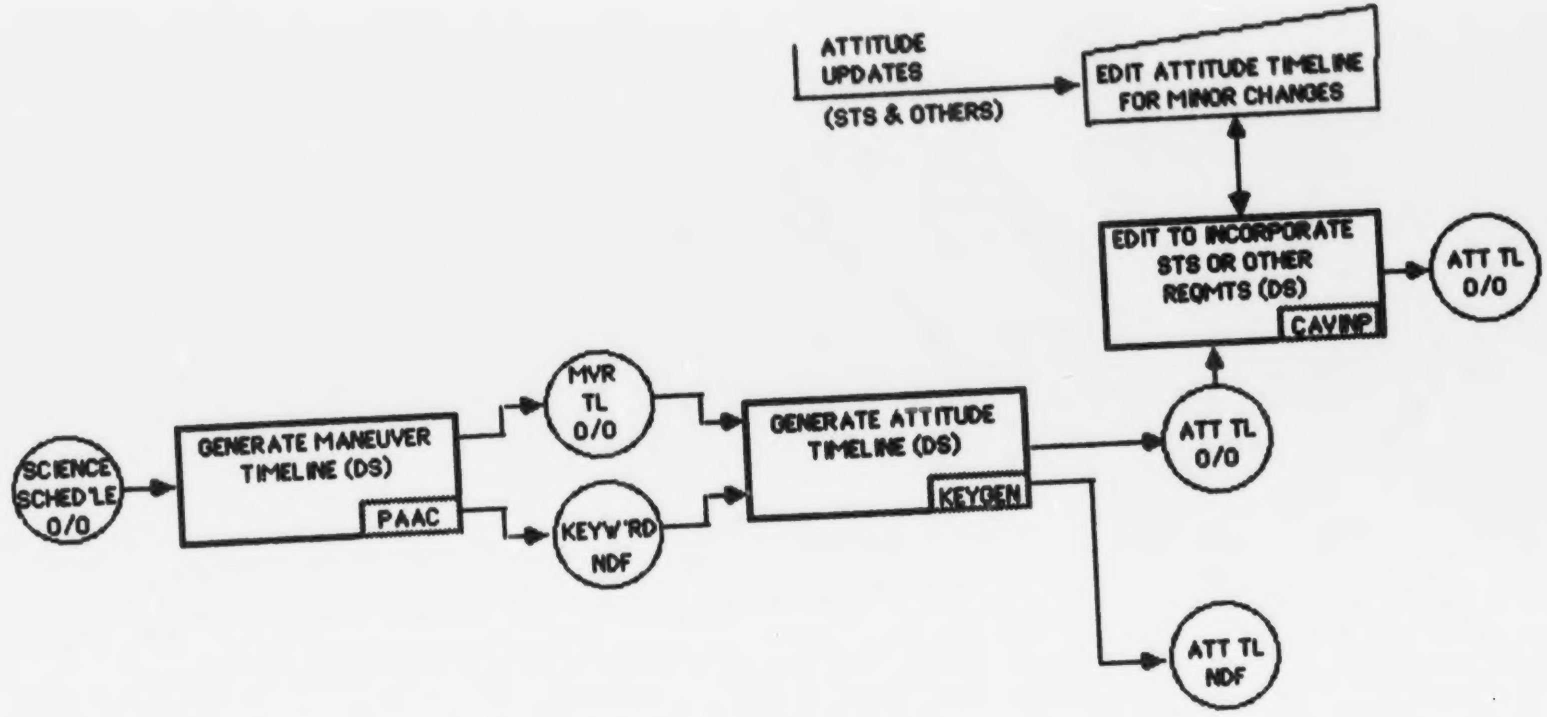
FUNCTION: ORBITAL ANALYSIS
SUBFUNCTION: DEDICATED STELLAR OBSERVATION GENERATION


EARTH SHADOW 0/0
CEL TARGETS 0/0
SAA AC/LOS 0/0
PI DEVELOPED
TIME GOAL ASCII
SUBCOO ASCII
OR
PI DEVELOPED
COO ASCII
MANUAL EDIT CAPABILITY PRIOR TO OUTPUT
CREATE COMMON FILE FOR ASTAR PROGRAM (DS)
READPI
ANG'LR DIST'CE ASCII
READPI ASCII
CREATE RESERVE PERIOD FILE (DS)
EDT
RESERVE PERIOD CONSIDERATIONS
- TIME FOR TARGETS
- CREW H/O CYCLE
- SYSTEMS REQMTS
- MOVING TARGETS
RESERVE PERIODS ASCII
MANUAL EDIT CAPABILITY OF INPUT AND OUTPUT
SCHEDULE SCIENCE OBSERVATIONS (DS)
ASTAR
SCIENCE SCHED'LE 0/0

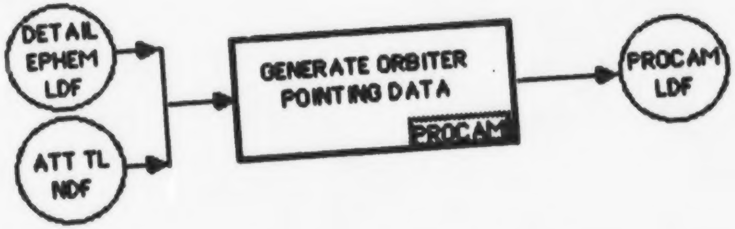
FUNCTION: ORBITAL ANALYSIS
SUBFUNCTION: ATTITUDE/MANEUVER TIMELINE GENERATION (MULTIDISCIPLINE)


ATTITUDE UPDATES
(STS & OTHERS)
EDIT ATTITUDE TIMELINE FOR MINOR CHANGES
** EDIT PREL. ATTITUDE TIMELINE TO PRODUCE FINAL ATTITUDE TIMELINE
* KEYWORD FILE IS CREATED MANUALLY USING CAVA/KEYGEN PRIOR TO GENERATING ATTITUDE TIMELINE.
PREL ATT TL 0/0
**
OR
EDIT CURRENT ATTITUDE T/L TO INCORPORATE STS OR OTHER REQMTS
CAVINP
ATT TL 0/0
*
KEYW'RD NDF
GENERATE ATTITUDE TIMELINE
KEYGEN
ATT TL 0/0
MVR TL 0/0
ATT TL NDF

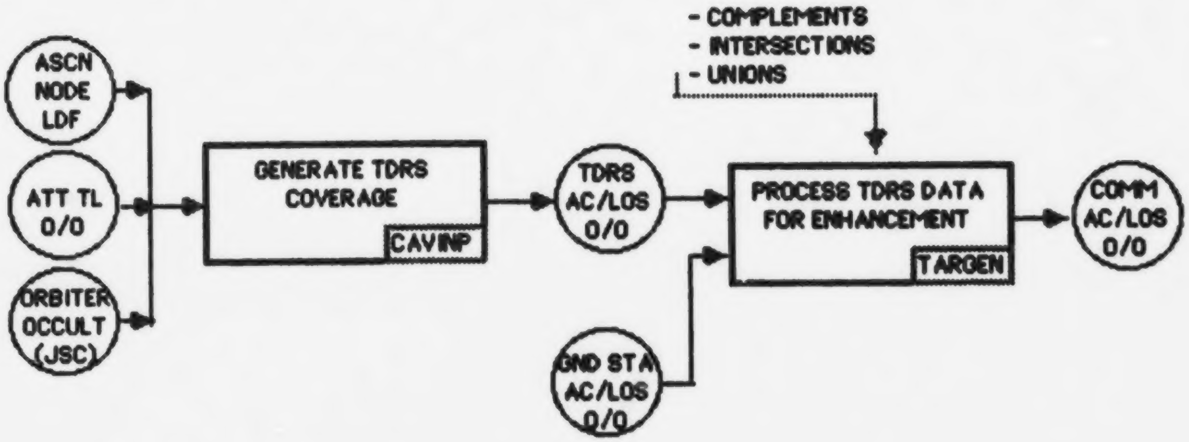
FUNCTION: ORBITAL ANALYSIS
SUBFUNCTION: ATTITUDE/MANEUVER TIMELINE GENERATION (DEDICATED STELLAR)


ATTITUDE
UPDATES
(STS & OTHERS)
EDIT ATTITUDE TIMELINE FOR MINOR CHANGES
EDIT TO INCORPORATE STS OR OTHER REQMTS (DS)
CAVINP
ATT TL 0/0
SCIENCE SCHED'LE 0/0
GENERATE MANEUVER TIMELINE (DS)
PAAC
MVR TL 0/0
KEYW'RD NDF
GENERATE ATTITUDE TIMELINE (DS)
KEYGEN
ATT TL 0/0
ATT TL NDF

FUNCTION: ORBITAL ANALYSIS
SUBFUNCTION: ORBITER POINTING DATA GENERATION

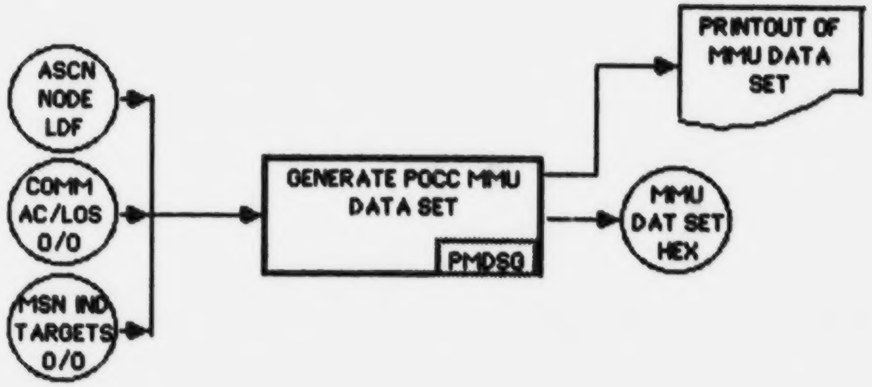

DETAIL
EPHEM
LDF
ATT TL
NDF
GENERATE ORBITER
POINTING DATA
PROCAM
PROCAM
LDF

FUNCTION: ORBITAL ANALYSIS
SUBFUNCTION: TDRS ACQ/LOSS GENERATION

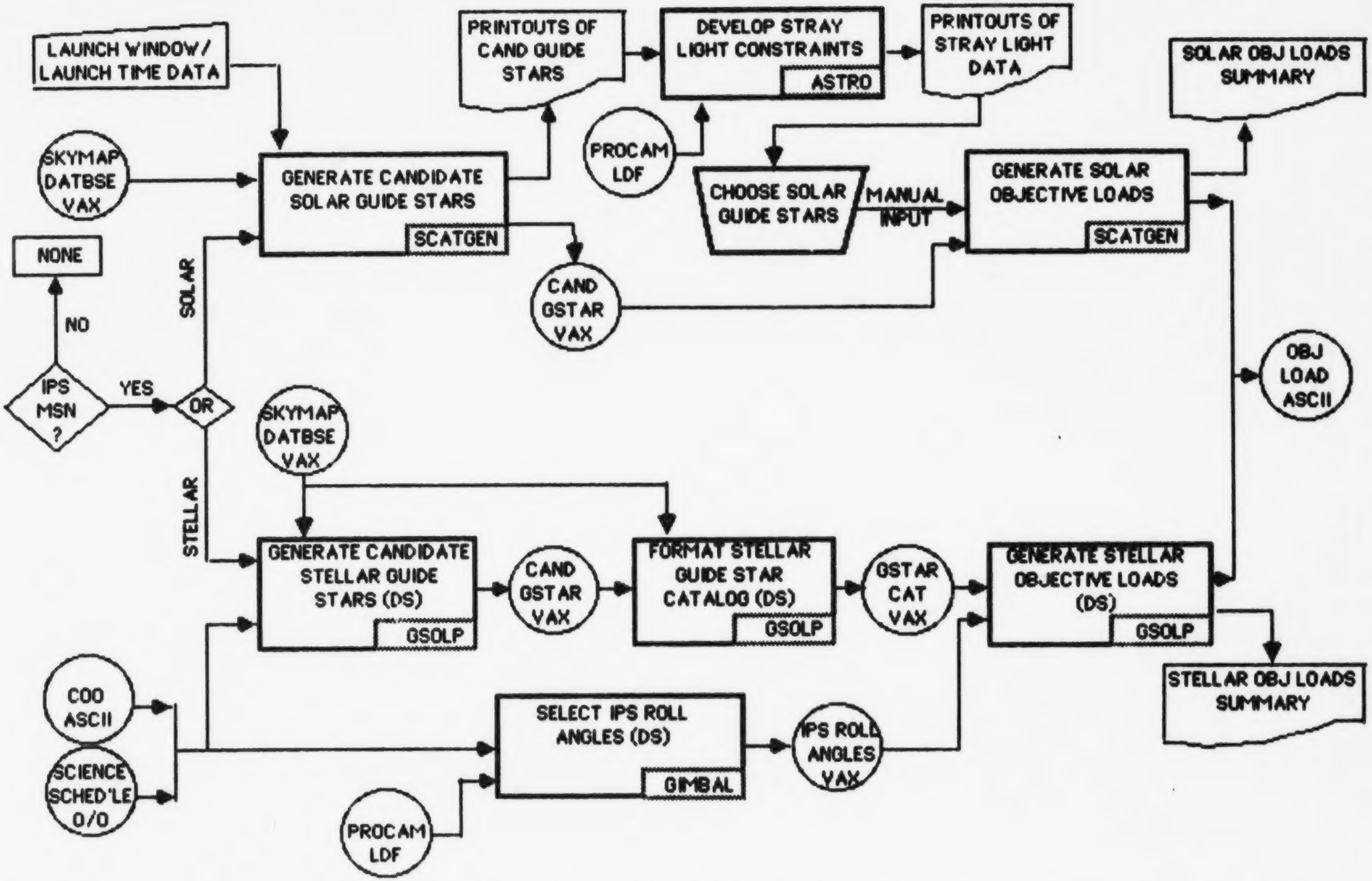

ASCN NODE LDF
ATT TL O/O
ORBITER OCCULT (JSC)
GENERATE TDRS COVERAGE
CAVINP
TDRS AC/LOS O/O
GND STA AC/LOS O/O
- COMPLEMENTS
- INTERSECTIONS
- UNIONS
PROCESS TDRS DATA FOR ENHANCEMENT
TARGEN
COMM AC/LOS O/O

NOTE: THIS PROCESS IS APPLICABLE TO EITHER MULTIDISCIPLINE OR DEDICATED STELLAR MISSIONS

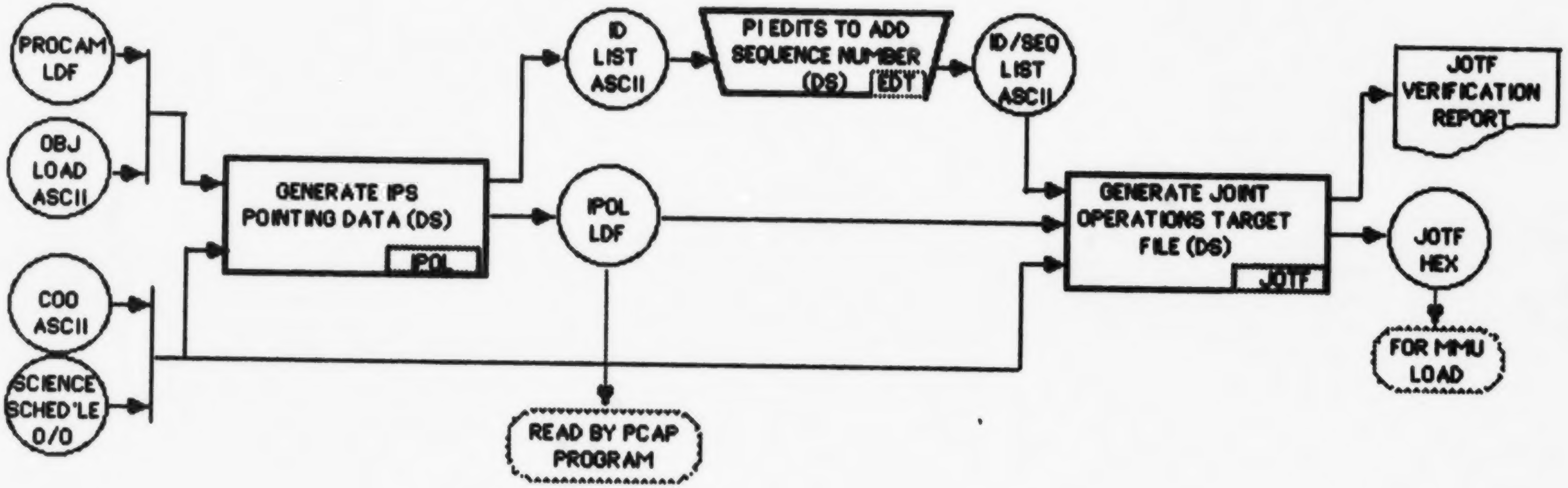
FUNCTION: ORBITAL ANALYSIS
SUBFUNCTION: POCC MMU DATA SET GENERATION


ASCN NODE LDF
COMM AC/LOS O/O
MSN IND TARGETS O/O
GENERATE POCC MMU DATA SET
PMDSG
PRINTOUT OF MMU DATA SET
MMU DAT SET HEX

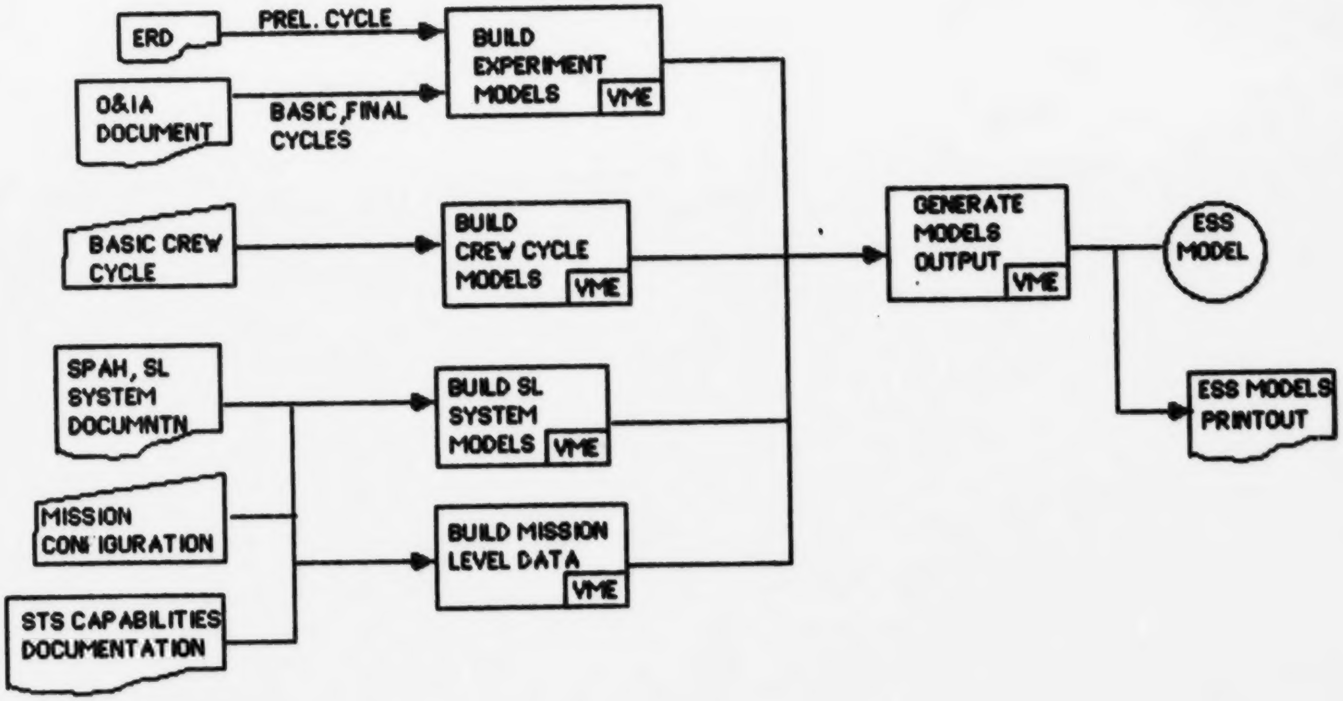
FUNCTION: ORBITAL ANALYSIS
SUBFUNCTION: OBJECTIVE LOADS GENERATION


LAUNCH WINDOW/ LAUNCH TIME DATA
SKYMAP DATBSE VAX
NONE
NO
IPS MSN ?
YES
OR
SOLAR
STELLAR
GENERATE CANDIDATE SOLAR GUIDE STARS
SCATGEN
PRINTOUTS OF CAND GUIDE STARS
CAND GSTAR VAX
DEVELOP STRAY LIGHT CONSTRAINTS
ASTRO
PROCAM LDF
PRINTOUTS OF STRAY LIGHT DATA
CHOOSE SOLAR GUIDE STARS
MANUAL INPUT
GENERATE SOLAR OBJECTIVE LOADS
SCATGEN
SOLAR OBJ LOADS SUMMARY
OBJ LOAD ASCII
SKYMAP DATBSE VAX
GENERATE CANDIDATE STELLAR GUIDE STARS (DS)
GSOLP
CAND GSTAR VAX
FORMAT STELLAR GUIDE STAR CATALOG (DS)
GSOLP
GSTAR CAT VAX
GENERATE STELLAR OBJECTIVE LOADS (DS)
GSOLP
STELLAR OBJ LOADS SUMMARY
COO ASCII
SCIENCE SCHED'LE O/O
SELECT IPS ROLL ANGLES (DS)
GIMBAL
PROCAM LDF
IPS ROLL ANGLES VAX

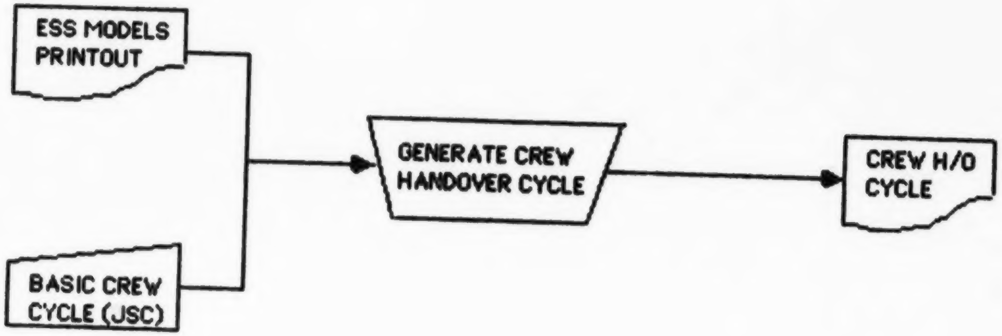
FUNCTION: ORBITAL ANALYSIS
SUBFUNCTION: JOINT OPERATIONS TARGET FILE GENERATION (DEDICATED STELLAR)


PROCAM LDF
OBJ LOAD ASCII
COO ASCII
SCIENCE SCHED'LE O/O
GENERATE IPS POINTING DATA (DS)
IPOL
ID LIST ASCII
IPOL LDF
READ BY PCAP PROGRAM
PI EDITS TO ADD SEQUENCE NUMBER (DS)
EDT
ID/SEQ LIST ASCII
GENERATE JOINT OPERATIONS TARGET FILE (DS)
JOTF
JOTF VERIFICATION REPORT
JOTF HEX
FOR MMU LOAD

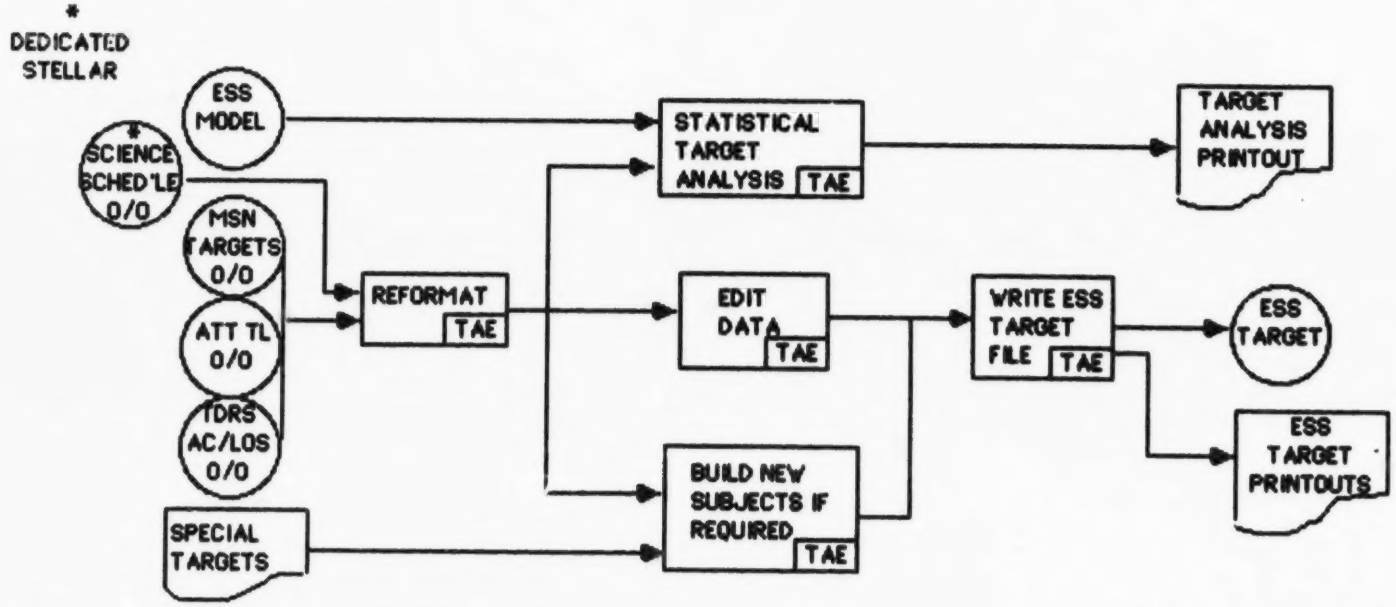
FUNCTION: MISSION TIMELINE ANALYSIS
SUBFUNCTION: CREATE MISSION TIMELINE MODELS


ERD
PREL. CYCLE
O&IA DOCUMENT
BASIC,FINAL CYCLES
BUILD EXPERIMENT MODELS
VME
BASIC CREW CYCLE
BUILD CREW CYCLE MODELS
VME
SPAH, SL SYSTEM DOCUMNTN
MISSION CONFIGURATION
STS CAPABILITIES DOCUMENTATION
BUILD SL SYSTEM MODELS
VME
BUILD MISSION LEVEL DATA
VME
GENERATE MODELS OUTPUT
VME
ESS MODEL
ESS MODELS PRINTOUT

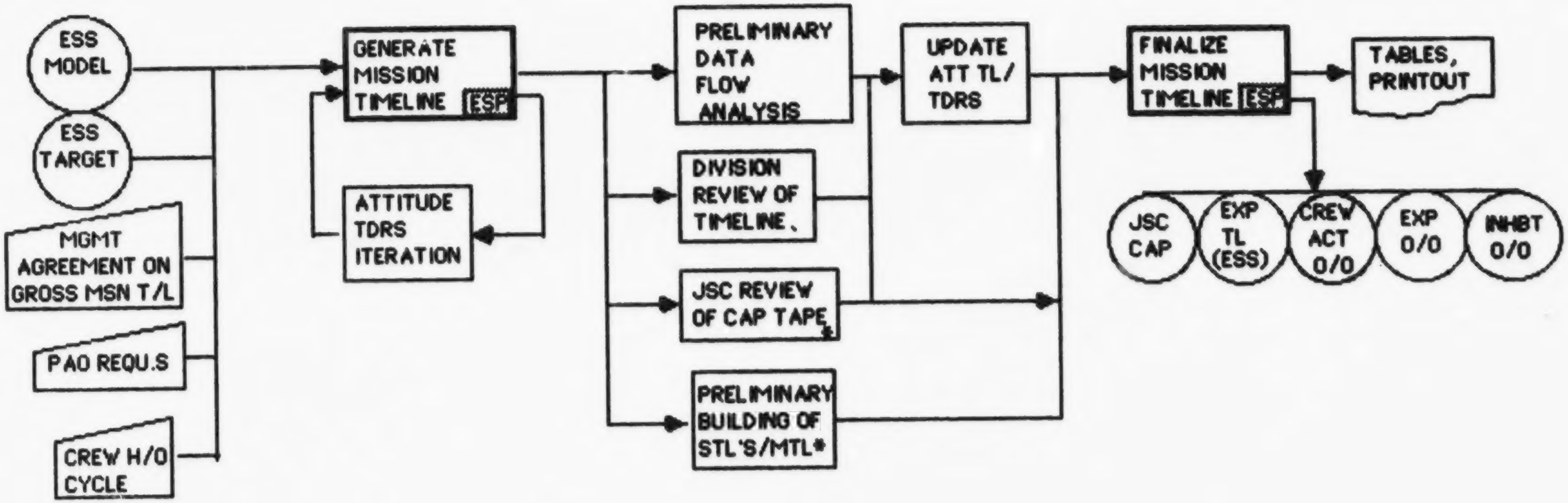
FUNCTION: MISSION TIMELINE ANALYSIS
SUBFUNCTION: GENERATE CREW H/O CYCLE


ESS MODELS PRINTOUT
BASIC CREW CYCLE (JSC)
GENERATE CREW HANDOVER CYCLE
CREW H/O CYCLE

FUNCTION: MISSION TIMELINE ANALYSIS
SUBFUNCTION: CREATE ESS TARGET FILE


* DEDICATED STELLAR
ESS MODEL
* SCIENCE SCHED'LE 0/0
MSN TARGETS 0/0
ATT TL 0/0
TDRS AC/LOS 0/0
SPECIAL TARGETS
REFORMAT TAE
STATISTICAL TARGET ANALYSIS TAE
EDIT DATA TAE
BUILD NEW SUBJECTS IF REQUIRED TAE
WRITE ESS TARGET FILE TAE
TARGET ANALYSIS PRINTOUT
ESS TARGET
ESS TARGET PRINTOUTS

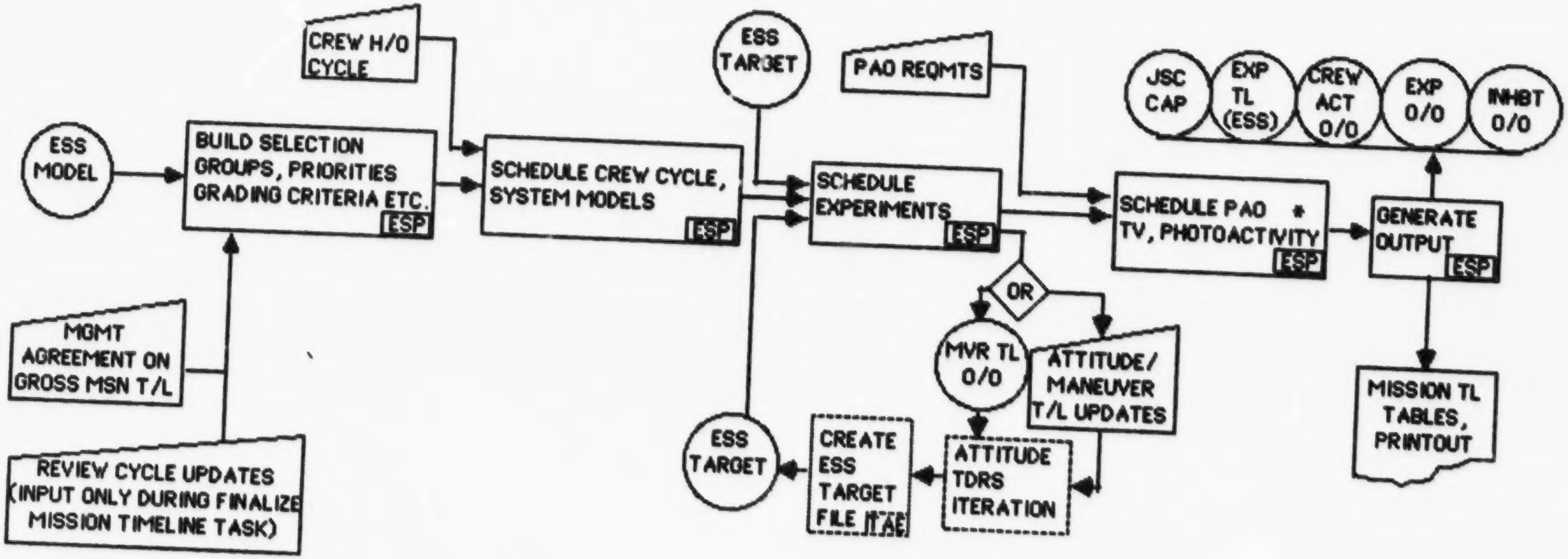
FUNCTION: MISSION TIMELINE ANALYSIS
SUBFUNCTION: MISSION TIMELINE GENERATION


ESS MODEL
ESS TARGET
MGMT AGREEMENT ON GROSS MSN T/L
PAO REQU.S
CREW H/O CYCLE
GENERATE MISSION TIMELINE
ESP
ATTITUDE TDRS ITERATION
PRELIMINARY DATA FLOW ANALYSIS
DIVISION REVIEW OF TIMELINE.
JSC REVIEW OF CAP TAPE*
PRELIMINARY BUILDING OF STL'S/MTL*
UPDATE ATT TL/ TDRS
FINALIZE MISSION TIMELINE
ESP
TABLES, PRINTOUT
JSC CAP
EXP TL (ESS)
CREW ACT 0/0
EXP 0/0
INHBT 0/0

* NOT PERFORMED IN PRELIMINARY CYCLE
NOTE: BOLD LINES INDICATE MISSION TIMELINE GENERATION TASKS.
REMAINING TASKS ARE SHOWN FOR CLARITY.

FUNCTION: MISSION TIMELINE ANALYSIS
SUBFUNCTION: MISSION TIMELINE GENERATION
TASK: GENERATE MISSION TIMELINE

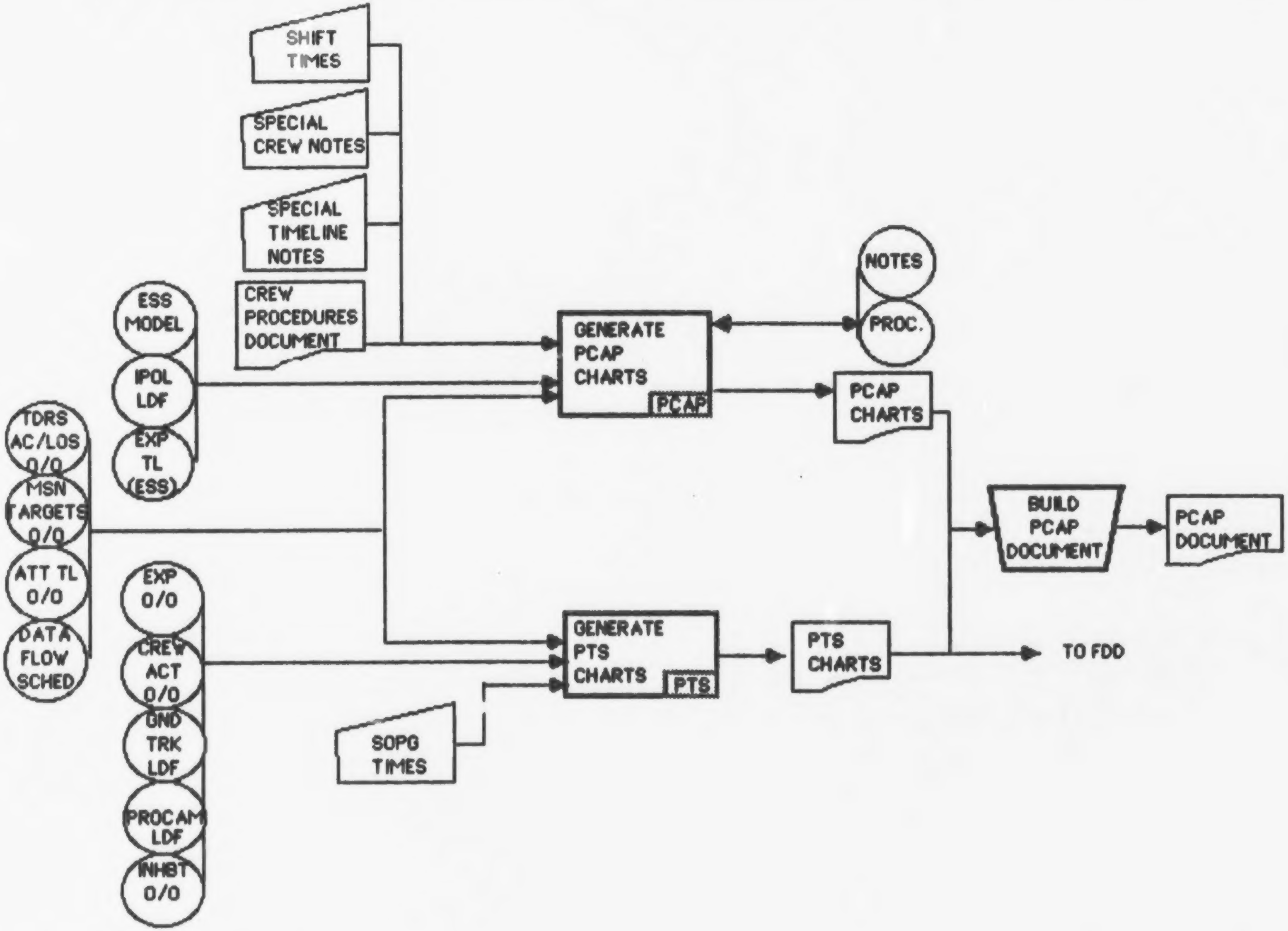
(FINALIZE MISSION TIMELINE TASK INCLUDES THE NECESSARY SUBTASKS OF THE GENERATE MISSION TIMELINE TASK)


ESS MODEL
BUILD SELECTION GROUPS, PRIORITIES GRADING CRITERIA ETC.
ESP
MGMT AGREEMENT ON GROSS MSN T/L
REVIEW CYCLE UPDATES (INPUT ONLY DURING FINALIZE MISSION TIMELINE TASK)
CREW H/O CYCLE
SCHEDULE CREW CYCLE, SYSTEM MODELS
ESP
ESS TARGET
SCHEDULE EXPERIMENTS
ESP
ESS TARGET
PAO REQMTS
OR
MVR TL O/O
ATTITUDE/ MANEUVER T/L UPDATES
ATTITUDE TDRS ITERATION
CREATE ESS TARGET FILE
ITAE
SCHEDULE PAO * TV, PHOTOACTIVITY
ESP
JSC CAP
EXP TL (ESS)
CREW ACT O/O
EXP O/O
INHBT O/O
GENERATE OUTPUT
ESP
MISSION TL TABLES, PRINTOUT

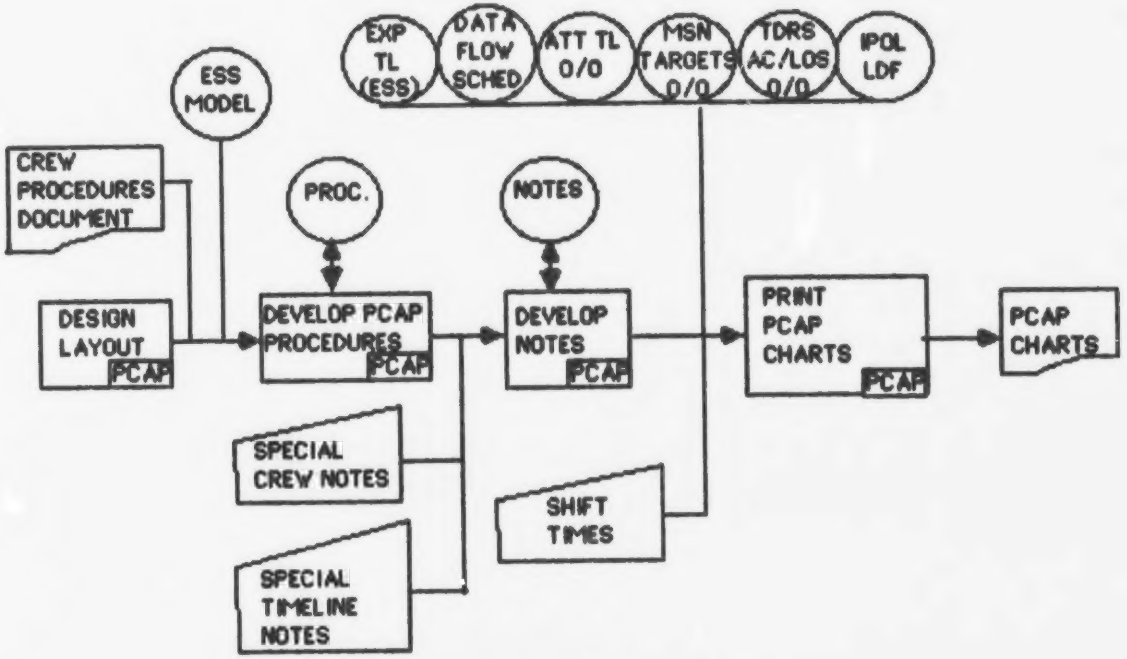
* NOT PERFORMED IN PRELIMINARY CYCLE

NOTE: DOTTED LINES INDICATE TASKS SHOWN FOR CLARITY AND ARE NOT MISSION TL GENERATION SUBTASKS

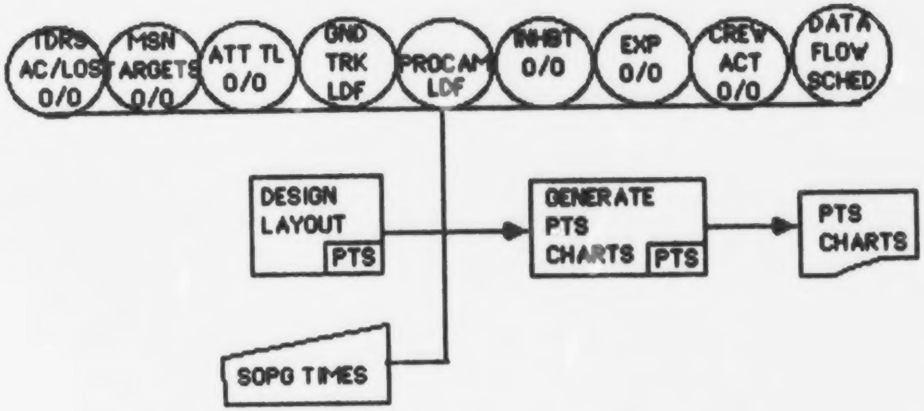
FUNCTION: MISSION TIMELINE ANALYSIS
SUBFUNCTION: PAYLOAD CREW ACTIVITY PLAN DEVELOPMENT


SHIFT TIMES
SPECIAL CREW NOTES
SPECIAL TIMELINE NOTES
CREW PROCEDURES DOCUMENT
ESS MODEL
IPOL LDF
EXP TL (ESS)
TDRS AC/LOS 0/0
MSN TARGETS 0/0
ATT TL 0/0
DATA FLOW SCHED
EXP 0/0
CREW ACT 0/0
GND TRK LDF
PROCAM LDF
INHBT 0/0
SOPG TIMES
GENERATE PCAP CHARTS
PCAP
NOTES
PROC.
PCAP CHARTS
GENERATE PTS CHARTS
PTS
PTS CHARTS
BUILD PCAP DOCUMENT
PCAP DOCUMENT
TO FDD

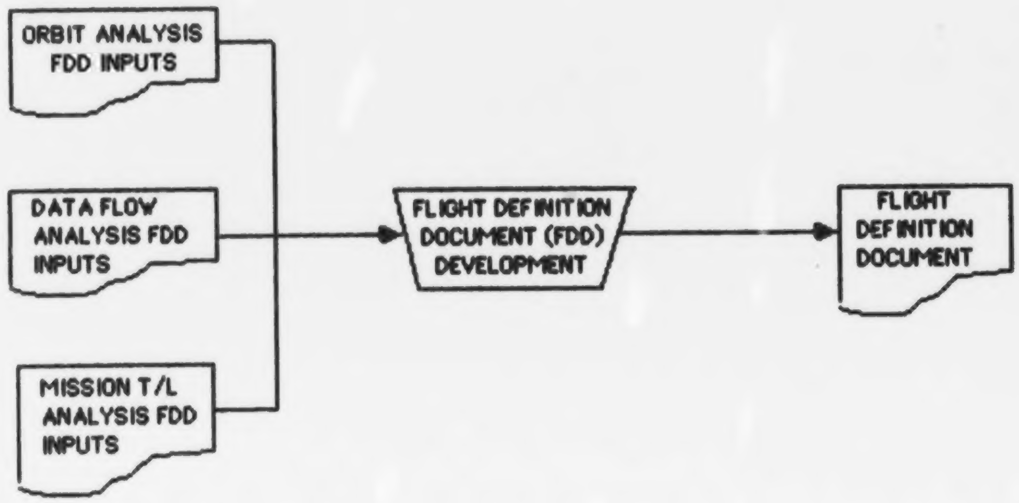
FUNCTION: MISSION TIMELINE ANALYSIS
SUBFUNCTION: PAYLOAD CREW ACTIVITY PLAN DEVELOPMENT
TASK: GENERATE PCAP CHARTS


EXP TL (ESS)
DATA FLOW SCHED
ATT TL 0/0
MSN TARGETS 0/0
TDRS AC/LOS 0/0
IPOL LDF
ESS MODEL
CREW PROCEDURES DOCUMENT
PROC.
NOTES
DESIGN LAYOUT
PCAP
DEVELOP PCAP PROCEDURES
PCAP
DEVELOP NOTES
PCAP
PRINT PCAP CHARTS
PCAP
PCAP CHARTS
SPECIAL CREW NOTES
SHIFT TIMES
SPECIAL TIMELINE NOTES

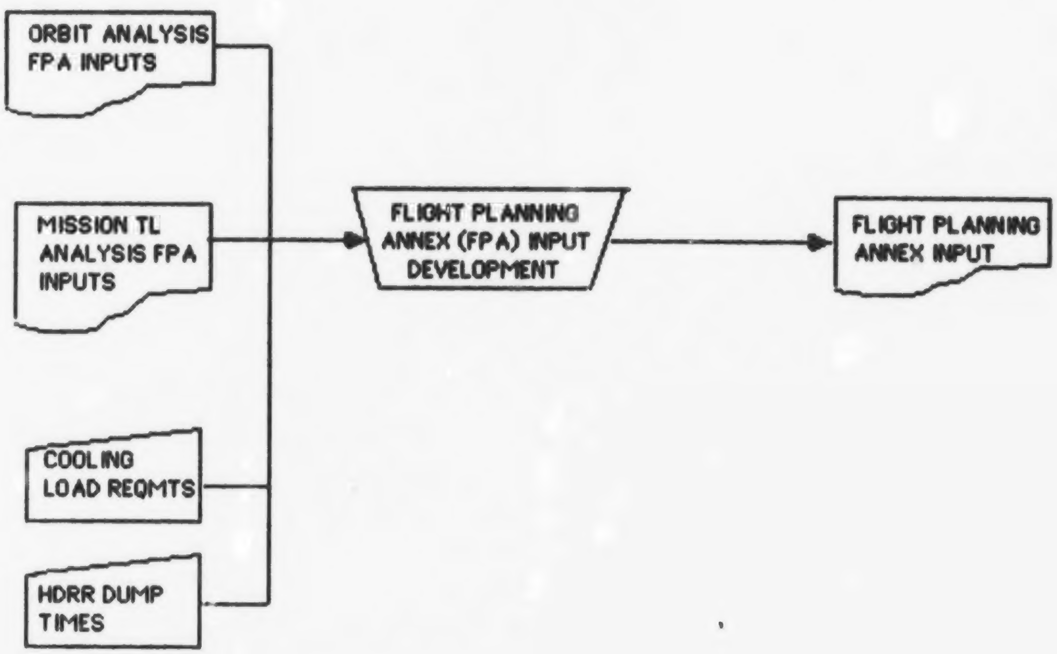
FUNCTION: MISSION TIMELINE ANALYSIS
SUBFUNCTION: PAYLOAD CREW ACTIVITY PLAN DEVELOPMENT
TASK: GENERATE PTS CHARTS


TDRS AC/LOS 0/0
MSN TARGETS 0/0
ATT TL 0/0
GND TRK LDF
PROCAM LDF
INHBT 0/0
EXP 0/0
CREW ACT 0/0
DATA FLOW SCHED
DESIGN LAYOUT
PTS
SOPG TIMES
GENERATE PTS CHARTS
PTS
PTS CHARTS

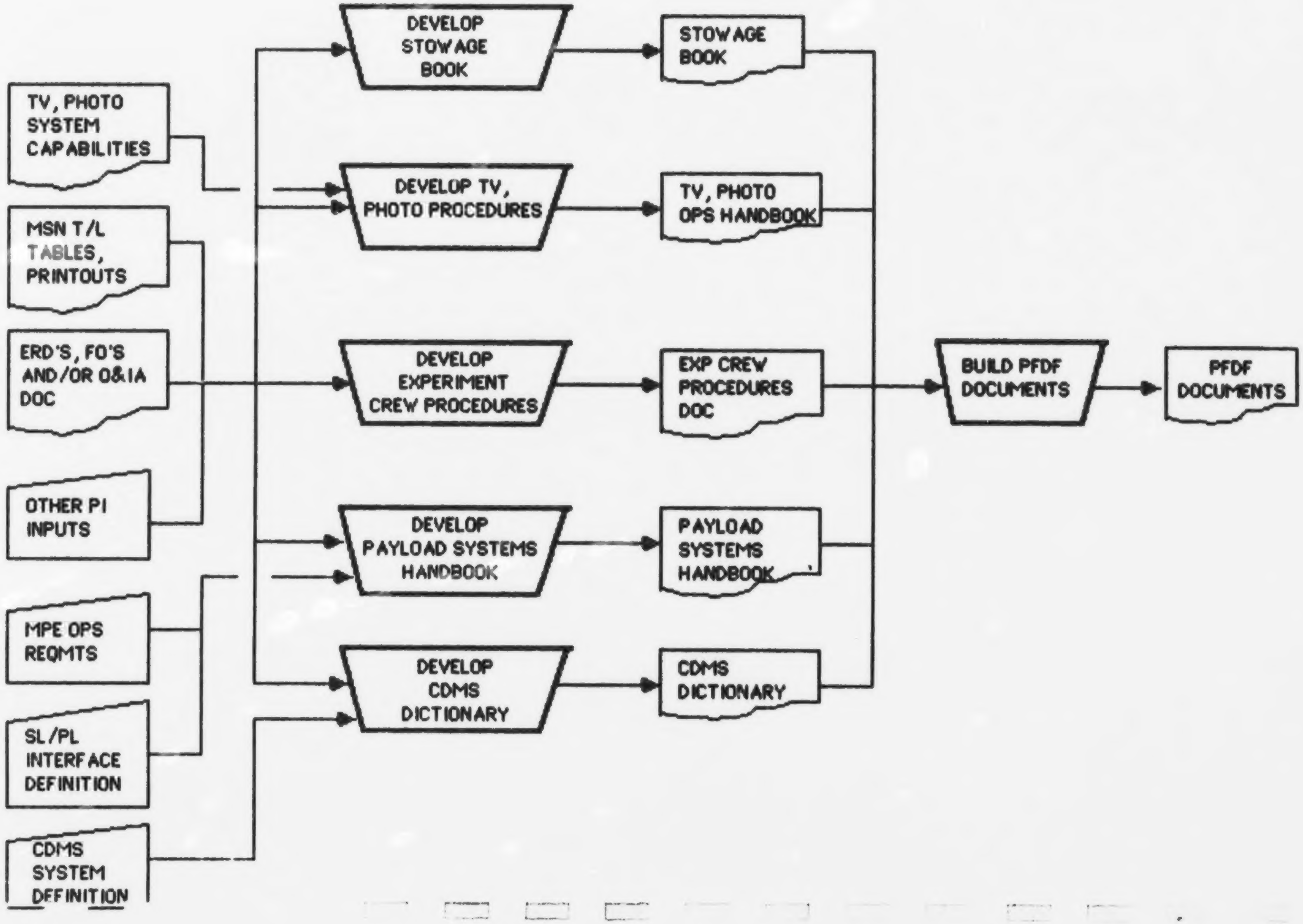
FUNCTION: FLIGHT DEFINITION DOCUMENT DEVELOPMENT


ORBIT ANALYSIS FDD INPUTS
DATA FLOW ANALYSIS FDD INPUTS
MISSION T/L ANALYSIS FDD INPUTS
FLIGHT DEFINITION DOCUMENT (FDD) DEVELOPMENT
FLIGHT DEFINITION DOCUMENT

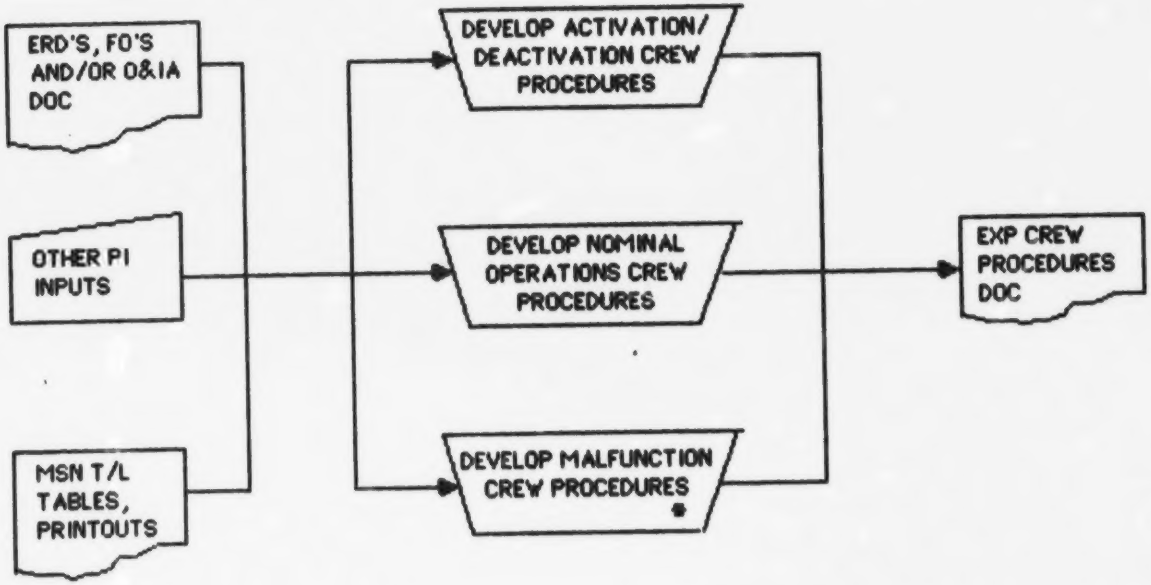
FUNCTION: FLIGHT PLANNING ANNEX INPUT DEVELOPMENT


ORBIT ANALYSIS FPA INPUTS
MISSION TL ANALYSIS FPA INPUTS
COOLING LOAD REQMTS
HDRR DUMP TIMES
FLIGHT PLANNING ANNEX (FPA) INPUT DEVELOPMENT
FLIGHT PLANNING ANNEX INPUT

FUNCTION: CREW PROCEDURES DEVELOPMENT

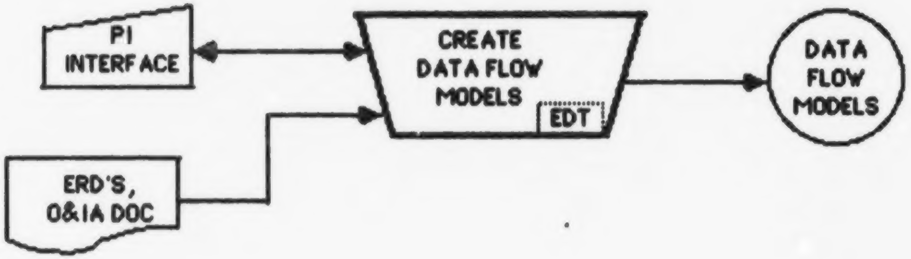

TV, PHOTO SYSTEM CAPABILITIES
MSN T/L TABLES, PRINTOUTS
ERD'S, FO'S AND/OR O&IA DOC
OTHER PI INPUTS
MPE OPS REQMTS
SL/PL INTERFACE DEFINITION
CDMS SYSTEM DEFINITION
DEVELOP STOWAGE BOOK
DEVELOP TV, PHOTO PROCEDURES
DEVELOP EXPERIMENT CREW PROCEDURES
DEVELOP PAYLOAD SYSTEMS HANDBOOK
DEVELOP CDMS DICTIONARY
STOWAGE BOOK
TV, PHOTO OPS HANDBOOK
EXP CREW PROCEDURES DOC
PAYLOAD SYSTEMS HANDBOOK
CDMS DICTIONARY
BUILD PFDF DOCUMENTS
PFDF DOCUMENTS

FUNCTION: CREW PROCEDURES DEVELOPMENT
SUBFUNCTION: DEVELOP EXPERIMENT CREW PROCEDURES

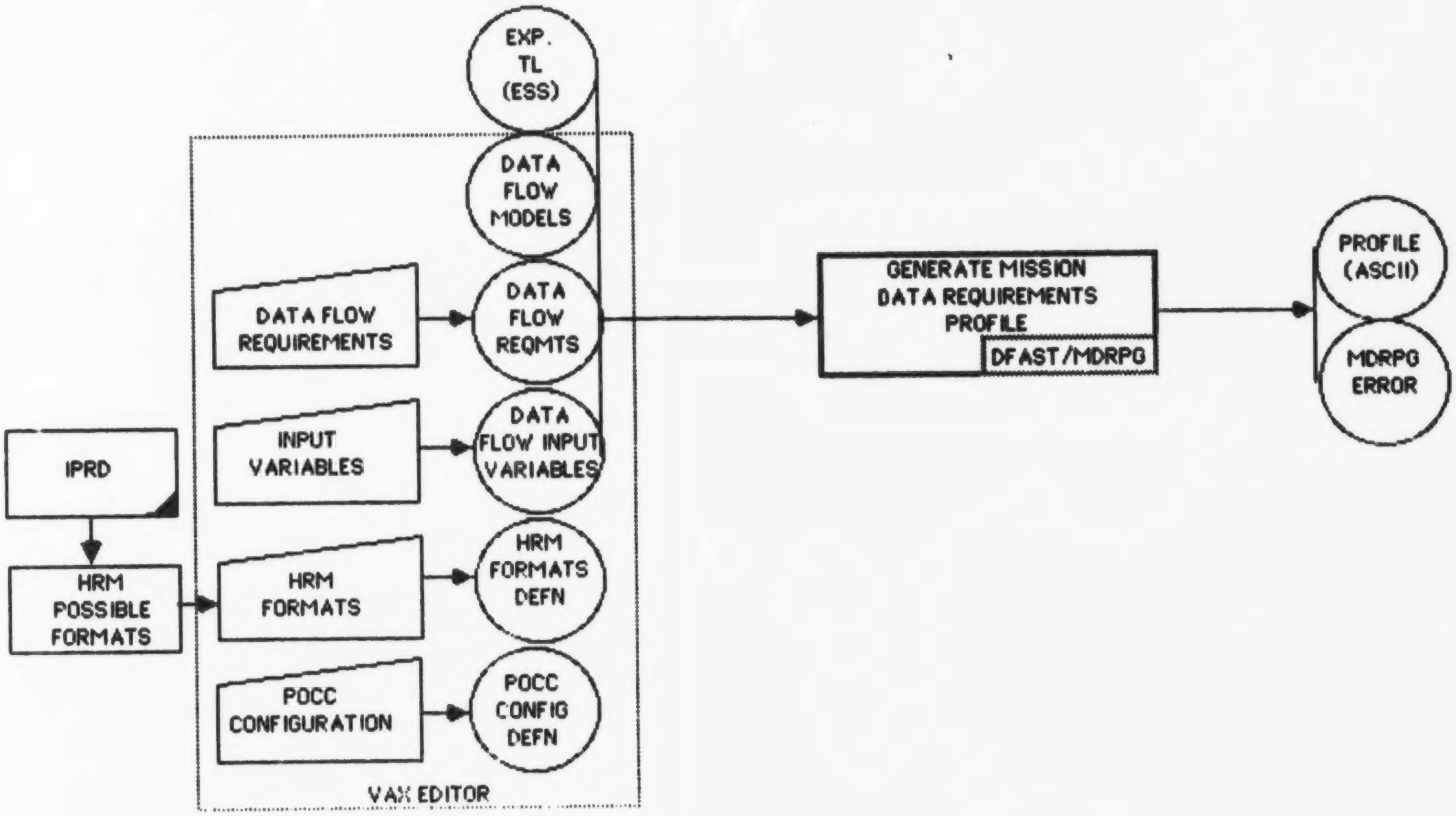

ERD'S, FO'S AND/OR O&IA DOC
OTHER PI INPUTS
MSN T/L TABLES, PRINTOUTS
DEVELOP ACTIVATION/ DEACTIVATION CREW PROCEDURES
DEVELOP NOMINAL OPERATIONS CREW PROCEDURES
DEVELOP MALFUNCTION CREW PROCEDURES *
EXP CREW PROCEDURES DOC

* NOT PERFORMED IN PRELIMINARY CYCLE

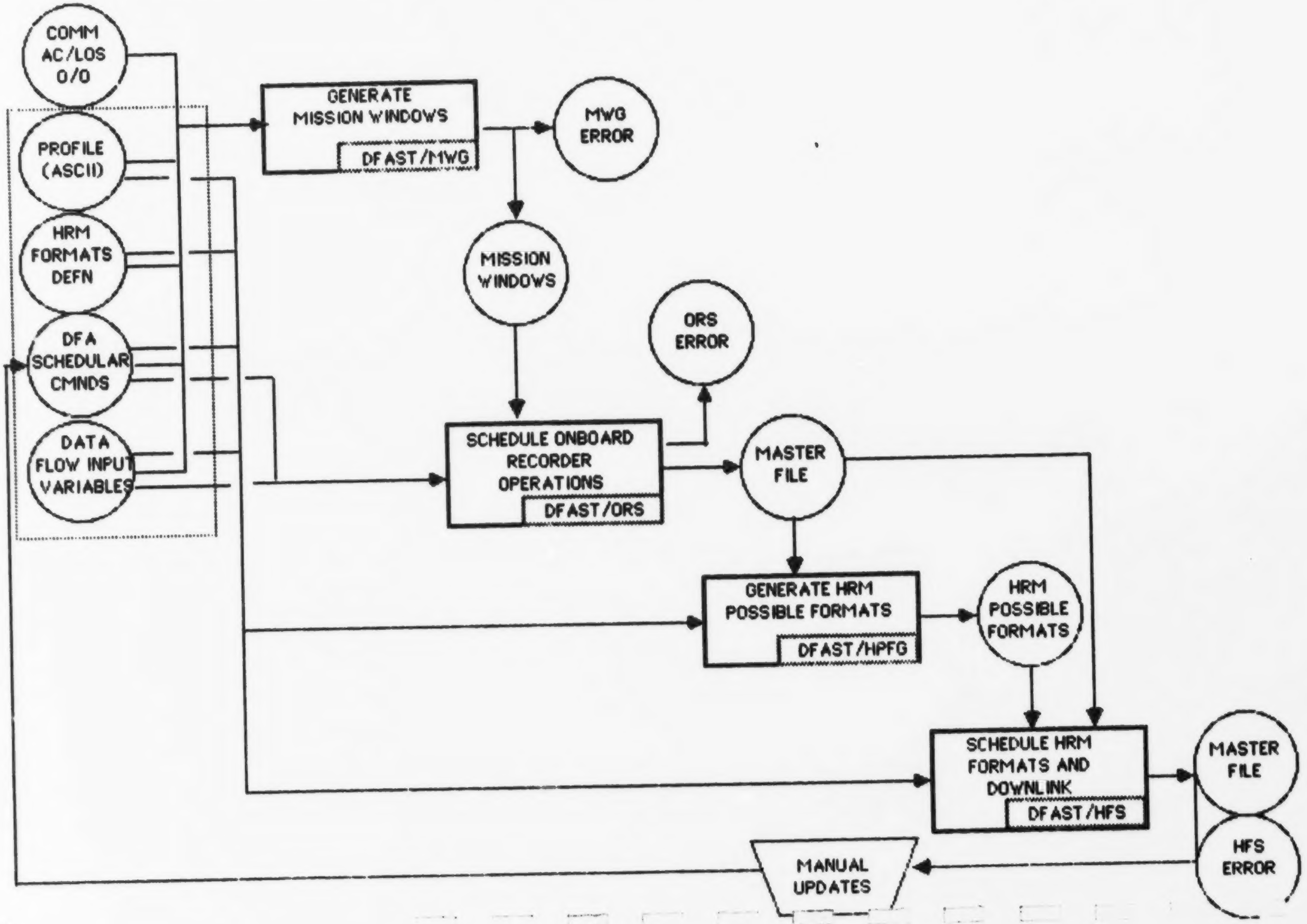
FUNCTION: DATA FLOW ANALYSIS
SUBFUNCTION: CREATE DATA FLOW MODELS


PI INTERFACE
ERD'S, O&IA DOC
CREATE DATA FLOW MODELS
EDT
DATA FLOW MODELS

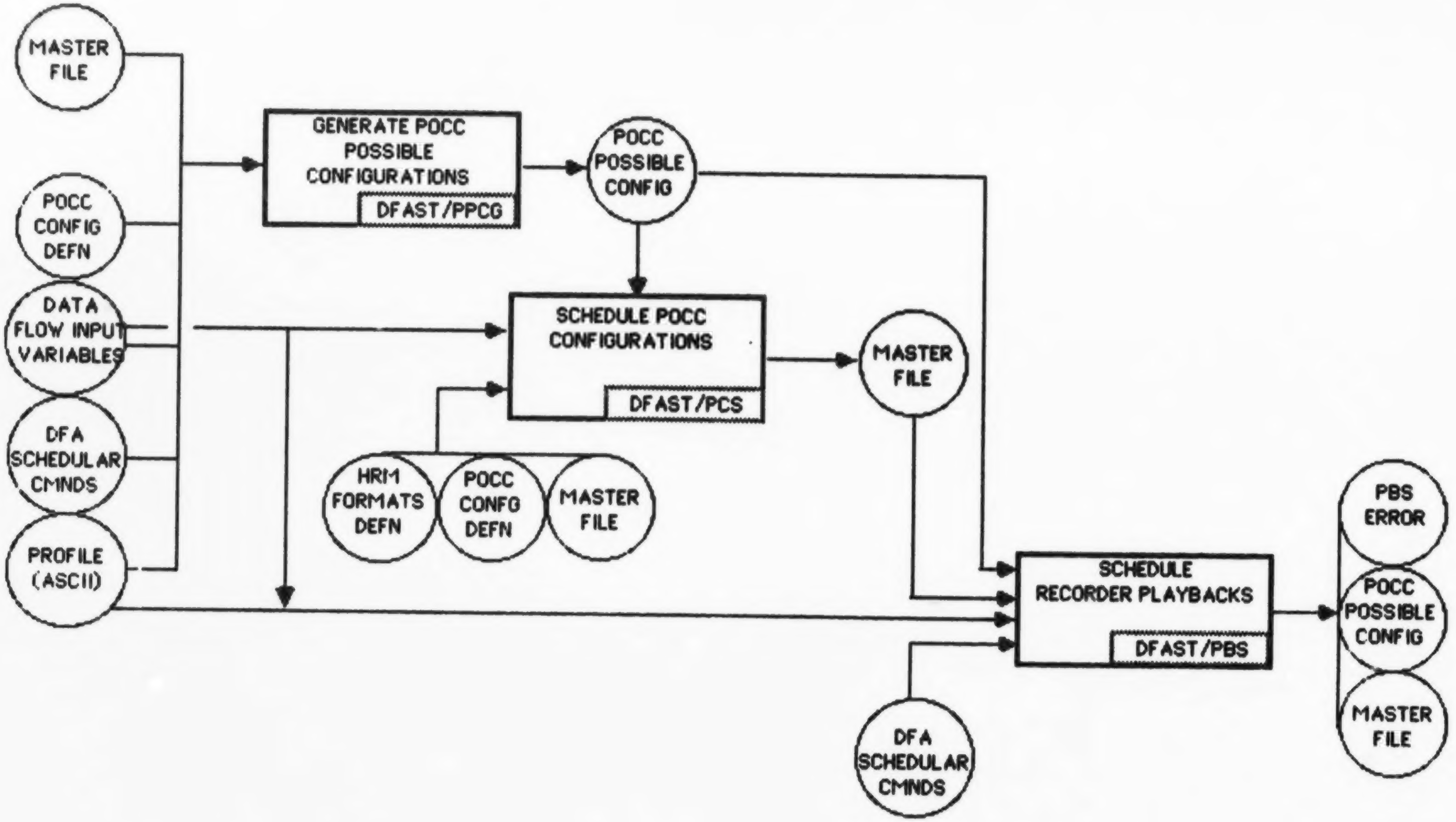
FUNCTION: DATA FLOW ANALYSIS
SUBFUNCTION: GENERATE MISSION DATA REQUIREMENTS PROFILE


EXP. TL (ESS)
DATA FLOW MODELS
DATA FLOW REQUIREMENTS
DATA FLOW REQMTS
INPUT VARIABLES
DATA FLOW INPUT VARIABLES
IPRD
HRM POSSIBLE FORMATS
HRM FORMATS
HRM FORMATS DEFN
POCC CONFIGURATION
POCC CONFIG DEFN
VAX EDITOR
GENERATE MISSION DATA REQUIREMENTS PROFILE
DFAST/MDRPG
PROFILE (ASCII)
MDRPG ERROR

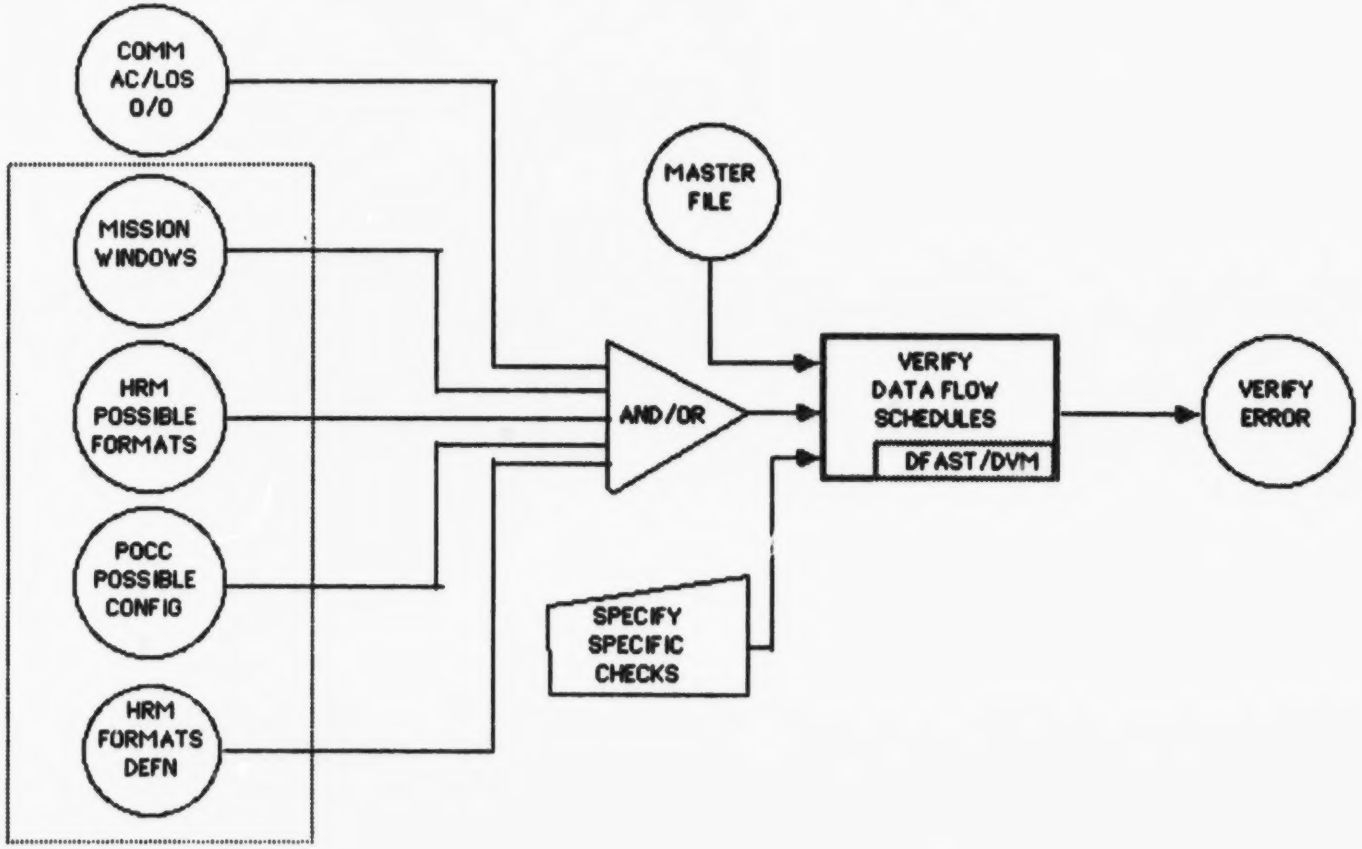
FUNCTION: DATA FLOW ANALYSIS
SUBFUNCTION: SCHEDULE ONBOARD DATA MANAGEMENT AND DOWNLINK


COMM AC/LOS O/O
PROFILE (ASCII)
HRM FORMATS DEFN
DFA SCHEDULAR CMNDS
DATA FLOW INPUT VARIABLES
GENERATE MISSION WINDOWS
DFAST/MWG
MWG ERROR
MISSION WINDOWS
SCHEDULE ONBOARD RECORDER OPERATIONS
DFAST/ORS
ORS ERROR
MASTER FILE
GENERATE HRM POSSIBLE FORMATS
DFAST/HPFG
HRM POSSIBLE FORMATS
SCHEDULE HRM FORMATS AND DOWNLINK
DFAST/HFS
MASTER FILE
HFS ERROR
MANUAL UPDATES

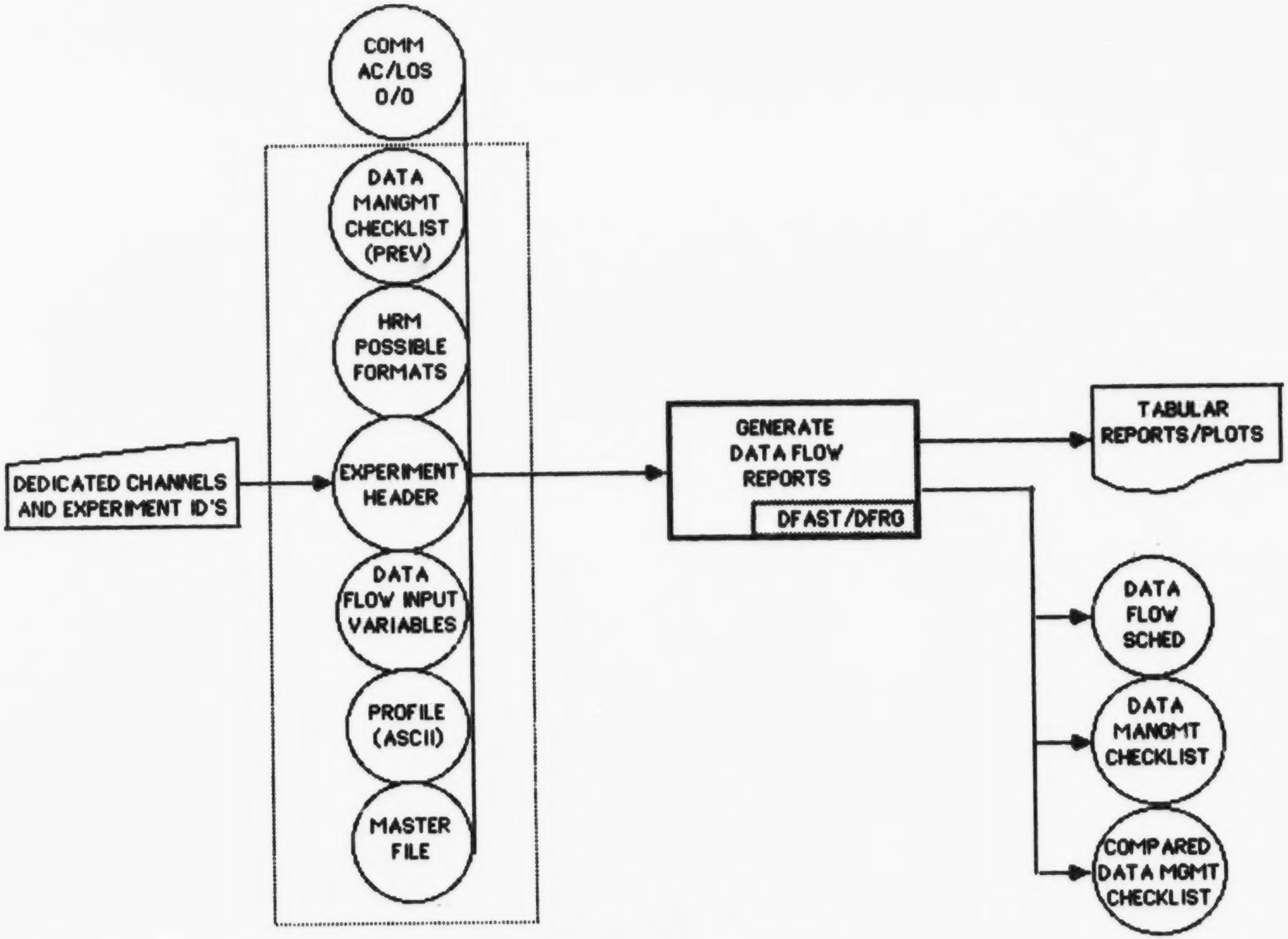
FUNCTION: DATA FLOW ANALYSIS
SUBFUNCTION: SCHEDULE POCC DATA CAPTURE/MANAGEMENT/DISTRIBUTION


MASTER FILE
POCC CONFIG DEFN
DATA FLOW INPUT VARIABLES
DFA SCHEDULAR CMNDS
PROFILE (ASCII)
GENERATE POCC POSSIBLE CONFIGURATIONS
DFAST/PPCG
POCC POSSIBLE CONFIG
SCHEDULE POCC CONFIGURATIONS
DFAST/PCS
MASTER FILE
HRM FORMATS DEFN
POCC CONFG DEFN
MASTER FILE
SCHEDULE RECORDER PLAYBACKS
DFAST/PBS
DFA SCHEDULAR CMNDS
PBS ERROR
POCC POSSIBLE CONFIG
MASTER FILE

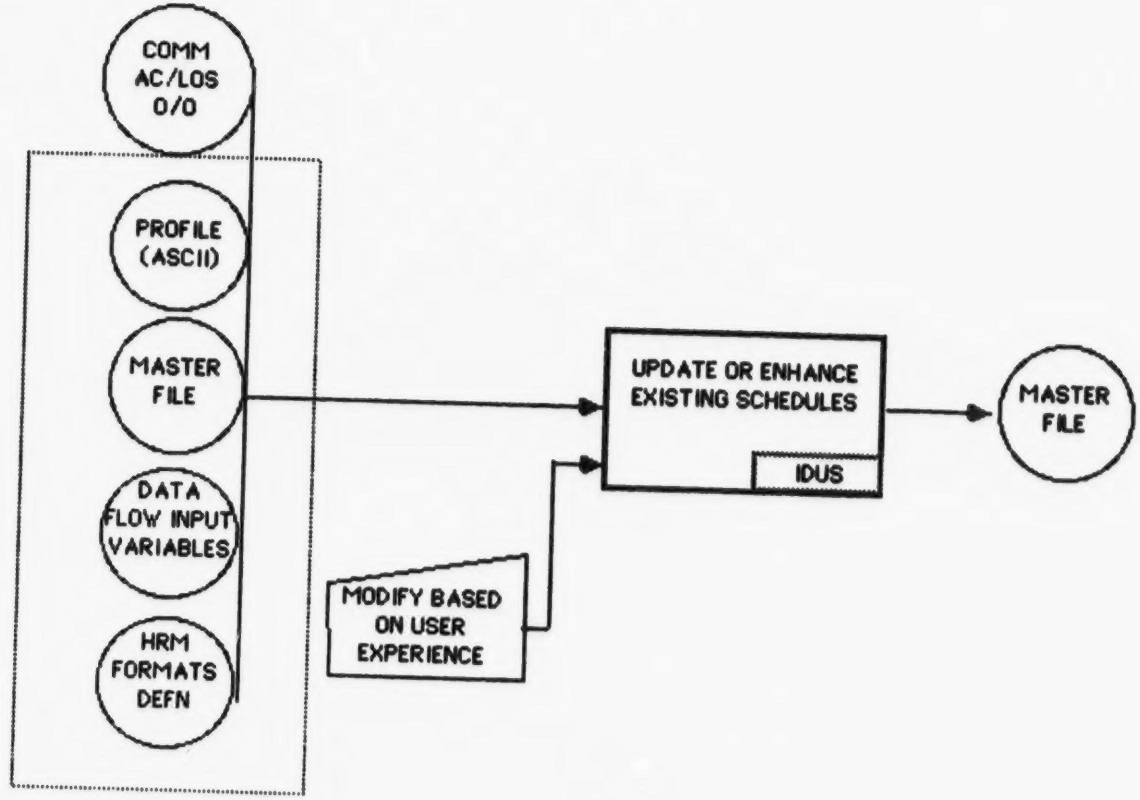
FUNCTION: DATA FLOW ANALYSIS
SUBFUNCTION: VERIFICATION OF DATA FLOW SCHEDULES


COMM
AC/LOS
O/O
MISSION
WINDOWS
HRM
POSSIBLE
FORMATS
POCC
POSSIBLE
CONFIG
HRM
FORMATS
DEFN
MASTER
FILE
AND/OR
SPECIFY
SPECIFIC
CHECKS
VERIFY
DATA FLOW
SCHEDULES
DF AST/DVM
VERIFY
ERROR

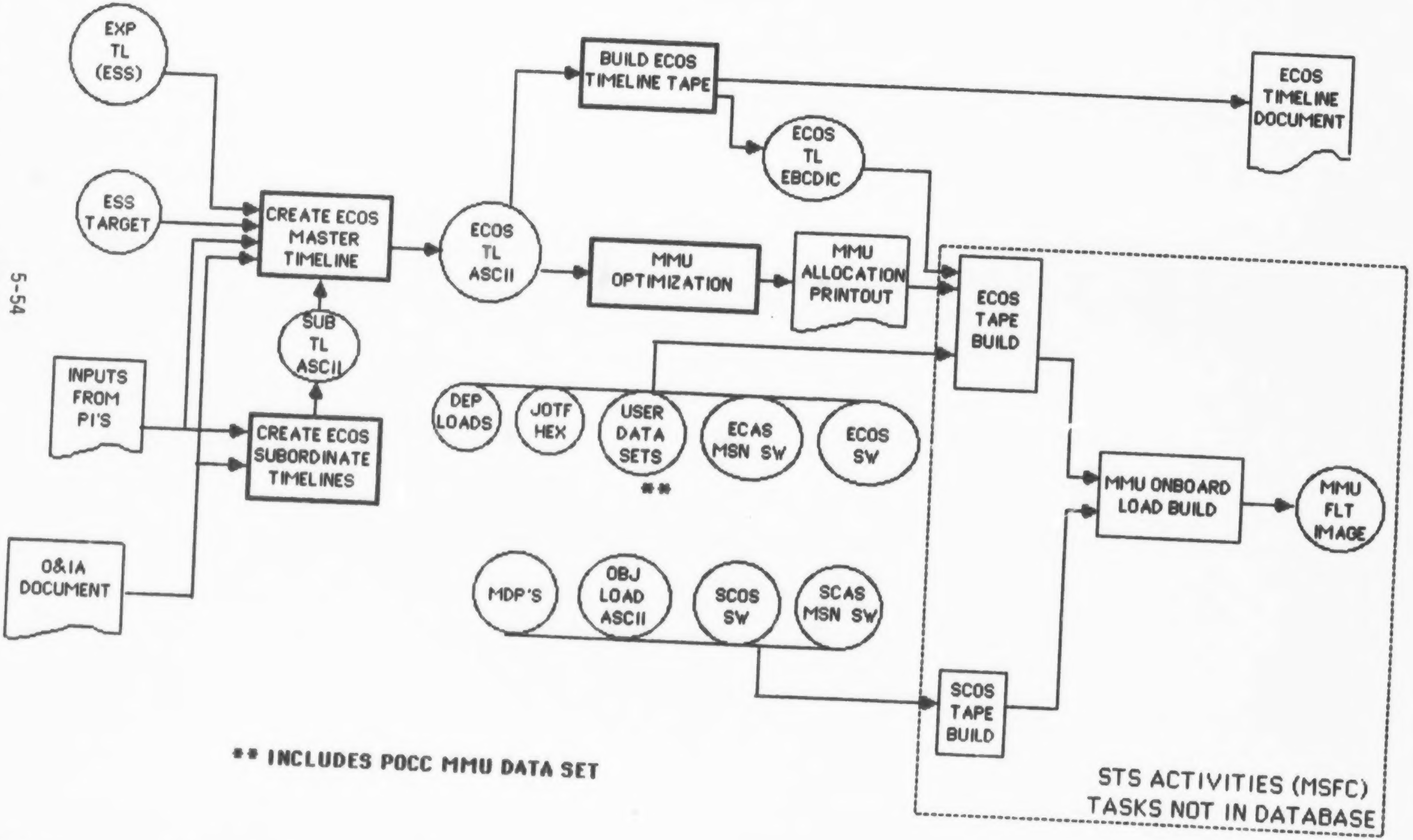
FUNCTION: DATA FLOW ANALYSIS
SUBFUNCTION: DATA FLOW AND SYSTEMS CONFIGURATION DOCUMENT DEVELOPMENT


DEDICATED CHANNELS AND EXPERIMENT ID'S
COMM AC/LOS O/O
DATA MANGMT CHECKLIST (PREV)
HRM POSSIBLE FORMATS
EXPERIMENT HEADER
DATA FLOW INPUT VARIABLES
PROFILE (ASCII)
MASTER FILE
GENERATE DATA FLOW REPORTS
DFAST/DFRG
TABULAR REPORTS/PLOTS
DATA FLOW SCHED
DATA MANGMT CHECKLIST
COMPARED DATA MGMT CHECKLIST

FUNCTION: DATA FLOW ANALYSIS
SUBFUNCTION: UPDATE OR ENHANCE EXISTING SCHEDULE

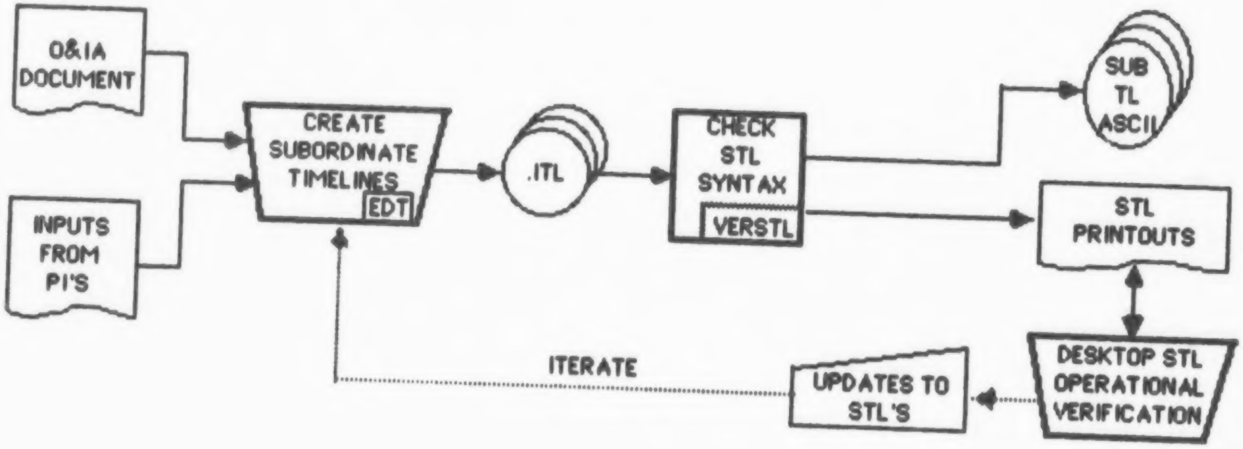

COMM AC/LOS O/O
PROFILE (ASCII)
MASTER FILE
DATA FLOW INPUT VARIABLES
HRM FORMATS DEFN
MODIFY BASED ON USER EXPERIENCE
UPDATE OR ENHANCE EXISTING SCHEDULES
IDUS
MASTER FILE

FUNCTION: MMU LOAD INPUT DEVELOPMENT

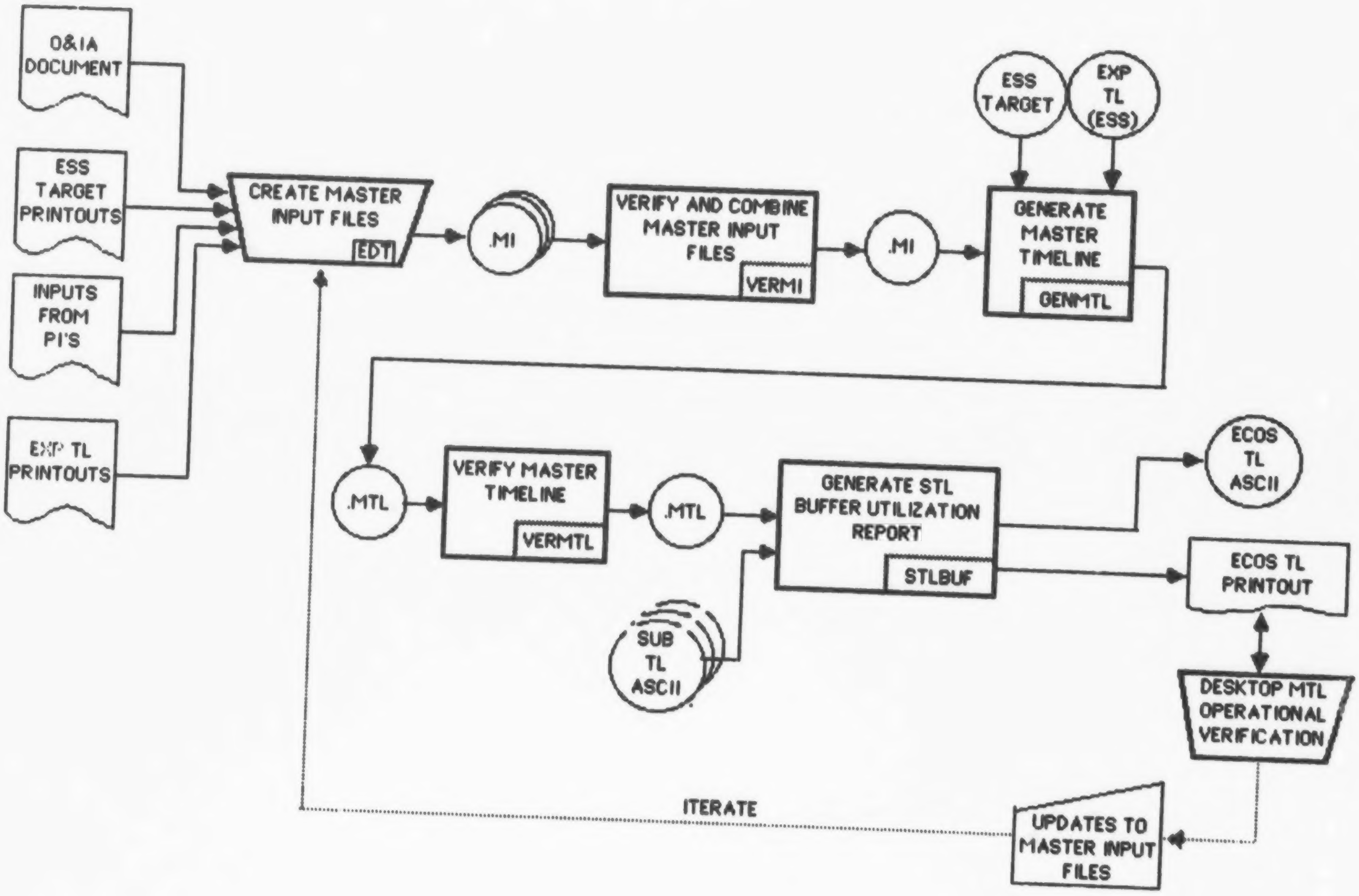

EXP TL (ESS)
ESS TARGET
INPUTS FROM PI'S
O&IA DOCUMENT
CREATE ECOS MASTER TIMELINE
SUB TL ASCII
CREATE ECOS SUBORDINATE TIMELINES
ECOS TL ASCII
BUILD ECOS TIMELINE TAPE
ECOS TIMELINE DOCUMENT
ECOS TL EBCDIC
MMU OPTIMIZATION
MMU ALLOCATION PRINTOUT
ECOS TAPE BUILD
DEP LOADS
JOTF HEX
USER DATA SETS **
ECAS MSN SW
ECOS SW
MDP'S
OBJ LOAD ASCII
SCOS SW
SCAS MSN SW
SCOS TAPE BUILD
MMU ONBOARD LOAD BUILD
MMU FLT IMAGE
STS ACTIVITIES (MSFC)
TASKS NOT IN DATABASE

** INCLUDES POCC MMU DATA SET

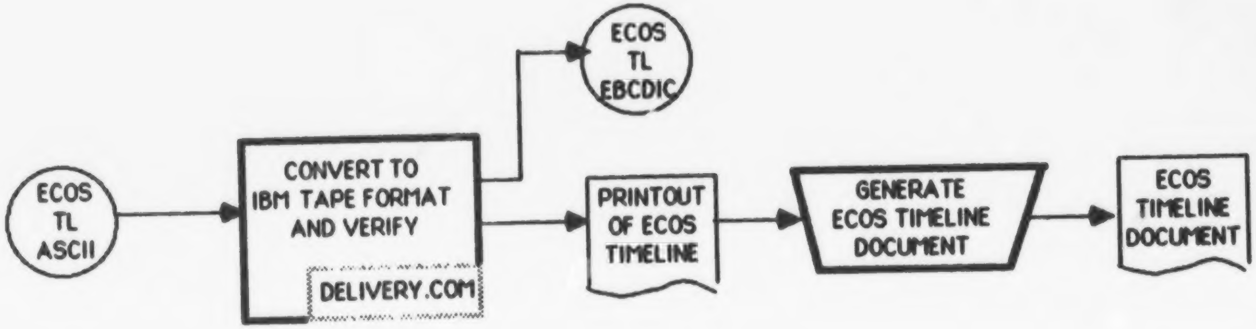
FUNCTION : MMU LOAD INPUT DEVELOPMENT
SUBFUNCTION : CREATE ECOS SUBORDINATE TIMELINES


O&IA DOCUMENT
INPUTS FROM PI'S
CREATE SUBORDINATE TIMELINES
EDT
.ITL
CHECK STL SYNTAX
VERSTL
SUB TL ASCII
STL PRINTOUTS
DESKTOP STL OPERATIONAL VERIFICATION
UPDATES TO STL'S
ITERATE

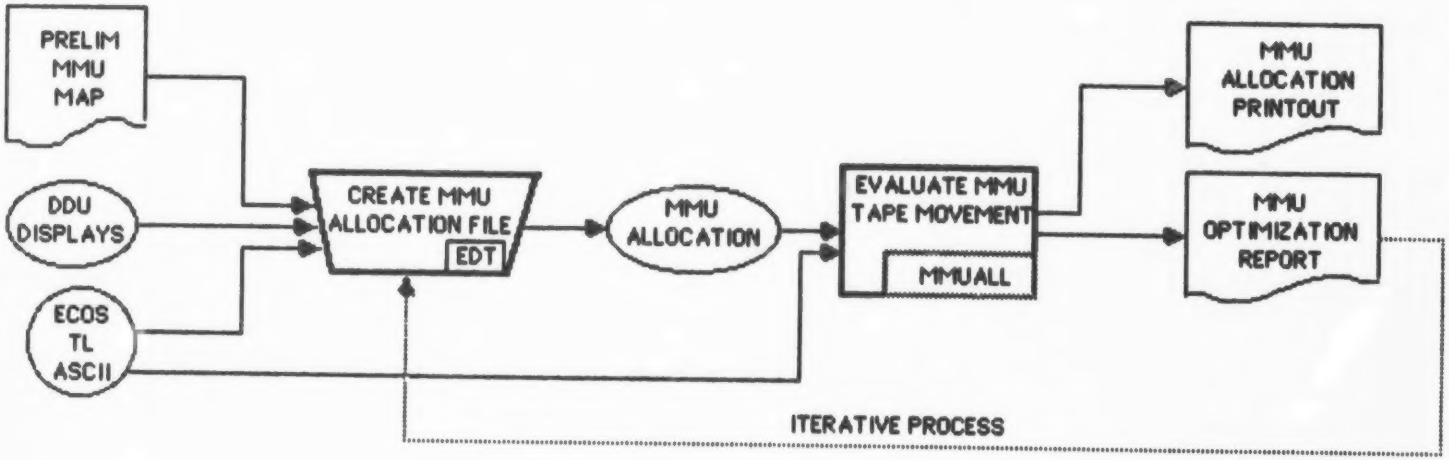
FUNCTION : MMU LOAD INPUT DEVELOPMENT
SUBFUNCTION : CREATE ECOS MASTER TIMELINE


O&IA DOCUMENT
ESS TARGET PRINTOUTS
INPUTS FROM PI'S
EXP TL PRINTOUTS
CREATE MASTER INPUT FILES
EDT
.MI
VERIFY AND COMBINE MASTER INPUT FILES
VERMI
.MI
ESS TARGET
EXP TL (ESS)
GENERATE MASTER TIMELINE
GENMTL
.MTL
VERIFY MASTER TIMELINE
VERMTL
.MTL
SUB TL ASCII
GENERATE STL BUFFER UTILIZATION REPORT
STLBUF
ECOS TL ASCII
ECOS TL PRINTOUT
DESKTOP MTL OPERATIONAL VERIFICATION
UPDATES TO MASTER INPUT FILES
ITERATE

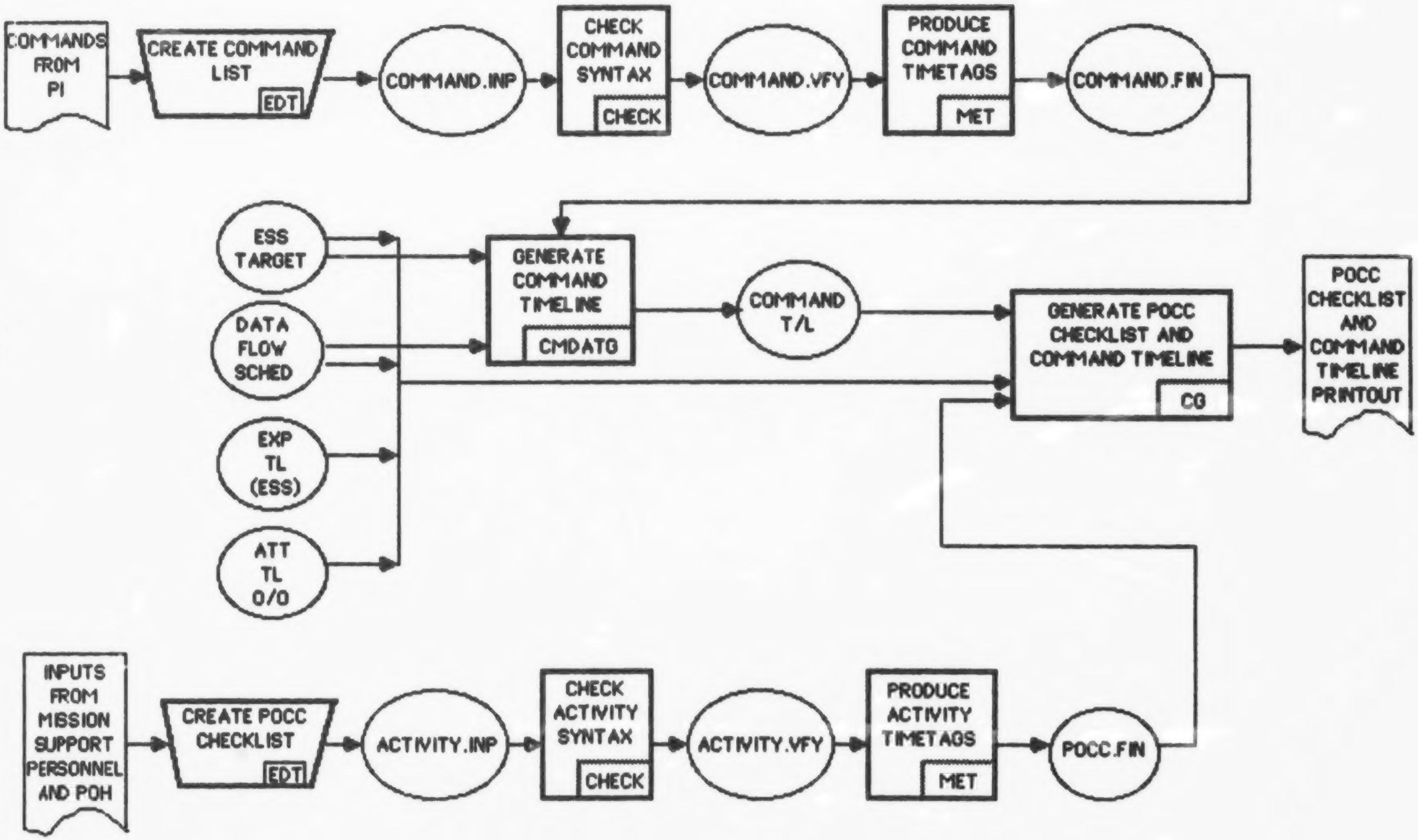
FUNCTION : MMU LOAD INPUT DEVELOPMENT
SUBFUNCTION : BUILD ECOS TIMELINE TAPE


ECOS TL ASCII
CONVERT TO IBM TAPE FORMAT AND VERIFY
DELIVERY.COM
ECOS TL EBCDIC
PRINTOUT OF ECOS TIMELINE
GENERATE ECOS TIMELINE DOCUMENT
ECOS TIMELINE DOCUMENT

FUNCTION : MMU LOAD INPUT DEVELOPMENT
SUBFUNCTION : MMU OPTIMIZATION


PRELIM MMU MAP
DDU DISPLAYS
ECOS TL ASCII
CREATE MMU ALLOCATION FILE
EDT
MMU ALLOCATION
EVALUATE MMU TAPE MOVEMENT
MMUALL
MMU ALLOCATION PRINTOUT
MMU OPTIMIZATION REPORT
ITERATIVE PROCESS

FUNCTION : EXPERIMENT COMMAND PLANNING DEVELOPMENT


COMMANDS FROM PI
CREATE COMMAND LIST
EDT
COMMAND.INP
CHECK COMMAND SYNTAX
CHECK
COMMAND.VFY
PRODUCE COMMAND TIMETAGS
MET
COMMAND.FIN
ESS TARGET
DATA FLOW SCHED
EXP TL (ESS)
ATT TL O/O
GENERATE COMMAND TIMELINE
CMDATG
COMMAND T/L
GENERATE POCC CHECKLIST AND COMMAND TIMELINE
CG
POCC CHECKLIST AND COMMAND TIMELINE PRINTOUT
INPUTS FROM MISSION SUPPORT PERSONNEL AND POH
CREATE POCC CHECKLIST
EDT
ACTIVITY.INP
CHECK ACTIVITY SYNTAX
CHECK
ACTIVITY.VFY
PRODUCE ACTIVITY TIMETAGS
MET
POCC.FIN

Section 6

TASK 3 - DEVELOP SPACE STATION MISSION PLANNING CONCEPT AND SOFTWARE REQUIREMENTS

6.1 ACTIVITIES AND ACCOMPLISHMENTS

As indicated previously, the objective of this task was to develop a payload mission planning concept consistent with the overall Space Station operations philosophy and to define a system of software requirements maximizing use of SL MIPS software modules (modified as necessary) to implement the concept.

The approach taken to this task consisted of four subtasks. First, basic definitions, groundrules, and assumptions were established; these pertained to the current Space Station design and operations concepts and philosophies, the scope of mission planning for Space Station, objectives/requirements to be achieved/satisfied by the approach to mission planning, the structure of organizations/personnel involved in mission planning, the number, purpose, and nature of planning cycles for Space Station, and the degree of allocation of mission planning functions between ground-based organizations and the on-board crew. The second subtask involved the construction of a set of functional flow diagrams defining the Space Station payload mission planning concept to a level of detail equivalent to the Spacelab functional flow diagrams. The third subtask then involved the identification of modified SL MIPS software modules or new computer programs to automate individual mission planning activities identified in the flow diagrams. The fourth and final subtask involved the summarization and systemization into a hierarchical structure of the new or modified SL MIPS software programs as the basis for preparation of a software development plan in Task 5.

Inputs to this study task were derived from a variety of sources:

- Space Station Program reference documents
- Space Station plans, study reports, white papers, briefings, meeting minutes, etc., published by NASA organizations, contractors, and working groups, including the NASA Space Station Operations Task Force and its panels
- Task 2 products and knowledge pertaining to the Spacelab mission planning process

The products of this task consist of the Space Station payload mission planning concept functional flow diagrams, a summary table describing the new and modified SL MIPS software modules required to implement the SS MPS concept, and the hierarchical structure of software for the SS MPS. The SS mission planning concept functional flow diagrams, including an explanation of the fundamental definitions, groundrules, and assumptions supporting the mission planning approach, as well as an explanation of the flow diagrams themselves, are contained in Subsection 6.2. The summary table of required new and modified SL MIPS software modules and the hierarchical structure of required software modules are presented in Subsection 6.3.

6.2 SPACE STATION MISSION PLANNING CONCEPT

6.2.1 Introduction

This section presents and explains the functional flow diagrams representative of the Space Station (SS) payload mission planning concept developed under Task 3 of the SS Mission Planning System (MPS) Development Study.

Prior to presenting the functional flow diagrams in Section 6.2.3 below, the following section provides the fundamental definitions, groundrules, and assumptions which support the approach to SS mission planning reflected in the flow diagrams.

6.2.2 Definitions, Groundrules and Assumptions

6.2.2.1 Space Station Physical Configuration

The Initial Operations Capability (IOC) configuration of the International Space Station was used as the baseline for this Study. It will be built up over a four year period by about 30 assembly missions and is designed for future growth and enhancements. It consists of the following elements:

- U.S. Laboratory Module
- ESA Laboratory Module
- JEM Laboratory and Exposed Facility
- Habit Module
- Mobile Servicing Center (MSC)
- MSC Maintenance Depot
- Mobile Transporter
- Servicing Facility
- Attached Payloads Platforms and Accommodation Equipment
- Pressurized Logistics Carrier
- Unpressurized Logistics Carrier
- JEM Experiment Logistics Module
- Airlock
- Hyperbaric Airlock
- Telerobotic Servicer
- Solar Power Module
- Truss Assembly
- Propulsion Assembly
- Resource Node 1
- Resource Node 2
- Resource Node 3
- Resource Node 4

In addition to the manned base described above, the current definition for the Space Station system includes co-orbiting and polar platforms.

Primary physical accommodations to payloads on the manned base will be provided by the laboratories and the attached payload platforms and accommodation equipment.

Additional detailed definition of the Space Station physical configuration may be found in JSC 30000, the Space Station Program Definition and Requirements Document (PDRD).

6.2.2.2 Space Station Flight Operations Scenario

The Space Station orbit will be nominally circular with a normal operative altitude of 463 km and an inclination of 28.5° (JSC 30000). Orbit characteristics will not be adjusted to accommodate particular payload requirements.

The Space Transportation System (STS) Space Shuttle will be the primary support vehicle to the Space Station. As the Space Station orbit decays, the STS will be planned to rendezvous with the Space Station for the purpose of accomplishing logistics resupply, payload equipment and crew changeout. Space Station reboost will be nominally performed after each STS visit.

6.2.2.3 Scope of Payload Mission Planning

For the purpose of this Study, the scope of payload mission planning was assumed to encompass the operations of multi-discipline payloads contained within or attached to the Space Station manned base elements. Excluded, therefore, were the operations of payloads on co-orbiting or polar platforms; it was assumed that the influences of these platforms on manned base payload operations will be input to the planning process in the form of Space Station operations constraints.

The various payload disciplines considered, particularly those whose operational requirements would include specific orbital environmental conditions, fields of view, or targets, were the same as those currently accommodated by the Spacelab mission planning process - namely,

- Astrophysics
- Solar physics
- Plasma physics
- Earth sciences
- Life sciences
- Material Science

The scope of mission planning was further assumed to apply to a "mission increment", the period (up to 90 days) of Space Station orbital operations bounded by STS visits (i.e., fixed payload complement).

The payload mission planning process was assumed to commence with definition of the payload complement and the corresponding accommodating Space Station elements for the mission increment.

The payload mission planning process activities were assumed to range from the collection of payload operations requirements data through the preparation of mission execution plans and procedures. It was further assumed that the process must accommodate real-time replanning, as well as pre-flight planning. (This is similar in scope to the Spacelab process, the definition of which provided an excellent foundation for identifying required Space Station planning activities.)

6.2.2.4 Approach to Payload Mission Planning

A. Objectives

The following objectives were established for the Space Station mission planning process, many of which were based on an assessment of the characteristics of, or lessons learned from the Spacelab mission planning process:

- decentralize planning; specifically maximize direct Space Station user involvement via user-friendly interfaces

- to ensure the use and production of common data, and to facilitate the integration of planning data, provide common capabilities at common planning levels (from the users up to an assumed payload operations integration center)

- automate to the maximum extent possible

- eliminate paper; emphasize readily accessible data bases between geographically dispersed locations of planning activity

- provide SS user flexibility within allocated resource constraints

- minimize the intensity (labor and computer) of planning activities

The final two objectives were especially encouraged by lessons learned from the Spacelab payload mission planning process, in which the relatively short duration mission (7-10 days) forced the planning of payload activities down to the minute to maximize the utilization of resources. To achieve these two objectives, an approach of using "resource allocation envelopes" was assumed, where such an envelope is a prescribed period of time with an associated vector of average resource utilization levels. In addition to achieving the aforementioned two objectives, this approach was justified by the longer duration mission for Space Station (compared to Spacelab). Also, the obvious disadvantage of this approach - the inefficient management and use of resources - can be overcome, if necessary, since the scheduling software can deal with scheduling data to a finer granularity.

B. Planning Organizations

Based primarily on concepts and definitions in use by the NASA Space Station Operations Task Force, the following mission planning organizations were defined:

- o Users - Principal Investigators (PI's)

- Planning Center - An organization which integrates the requirements, planning, and operations of a particular science/engineering discipline or of a particular Space Station physical element (e.g., US Lab)

- Payload Operations Integration Center (POIC) - The organization responsible for integrating payload operations plans from all the planning centers and for providing the primary interface between the user community and the Space Station Systems Operations organization.

- Space Station Systems Operations - the organization responsible for overall management and integration of Space Station operations

- Investigator Working Group (IWG) - An organization of users headed by a mission scientist to encourage cooperative science operations and to resolve conflicts among users.

The IWG is an organization successfully employed in the Spacelab process. IWG's have therefore been recommended to be established for Space Station at each planning center and at the POIC planning levels.

Whether planning centers will be organized around science/engineering disciplines (discipline centers) or around Space Station physical elements (element centers), is a matter to be decided by NASA and its international partners. The matter has been discussed at length by the NASA Space Station Operations Task Force. The two approaches are depicted graphically in Figures 6.2.2-1 and 6.2.2-2. A third hybrid approach which employs both discipline centers and element centers in-line in the planning process is depicted in Figure 6.2.2-3, but has been discarded because of the complex network of planning interfaces.

The overall advantage to the discipline center approach is the enhancement of cooperative science, while the advantage to the element center approach is that it directly supports the analytical integration process for SS elements and allows resource allocation/utilization planning to be controlled/verified for compatibility with element design/operational capabilities as planning is integrated. Under the discipline center approach, control/verification of resource allocation/utilization planning versus SS element capabilities must be centralized at the POIC.

For this Study, the mission planning concept has been derived to accommodate either discipline centers or element centers.

C. On-Board Crew Mission Planning

Based on MSFC guidance for this Study, the provision of planning capabilities to the on-board crew has been limited to a minor real-time replanning capability. Space Station Phase B studies have shown the crew to be the most critical Space Station resource. Also, astronaut corps inputs to the NASA Space Station Operations Task Force have indicated a preference for no mission planning responsibility. Therefore, crew utilization should be restricted to activities which must be performed on-board in order to maximize crew availability for experimentation. Furthermore, on-board planning will place a significant demand on on-board resources (e.g., mass storage). For these reasons, providing the on-board crew any mission planning capability is subject to reconsideration, in favor of increasing the automation of mission planning activities on the ground to minimize manpower requirements.

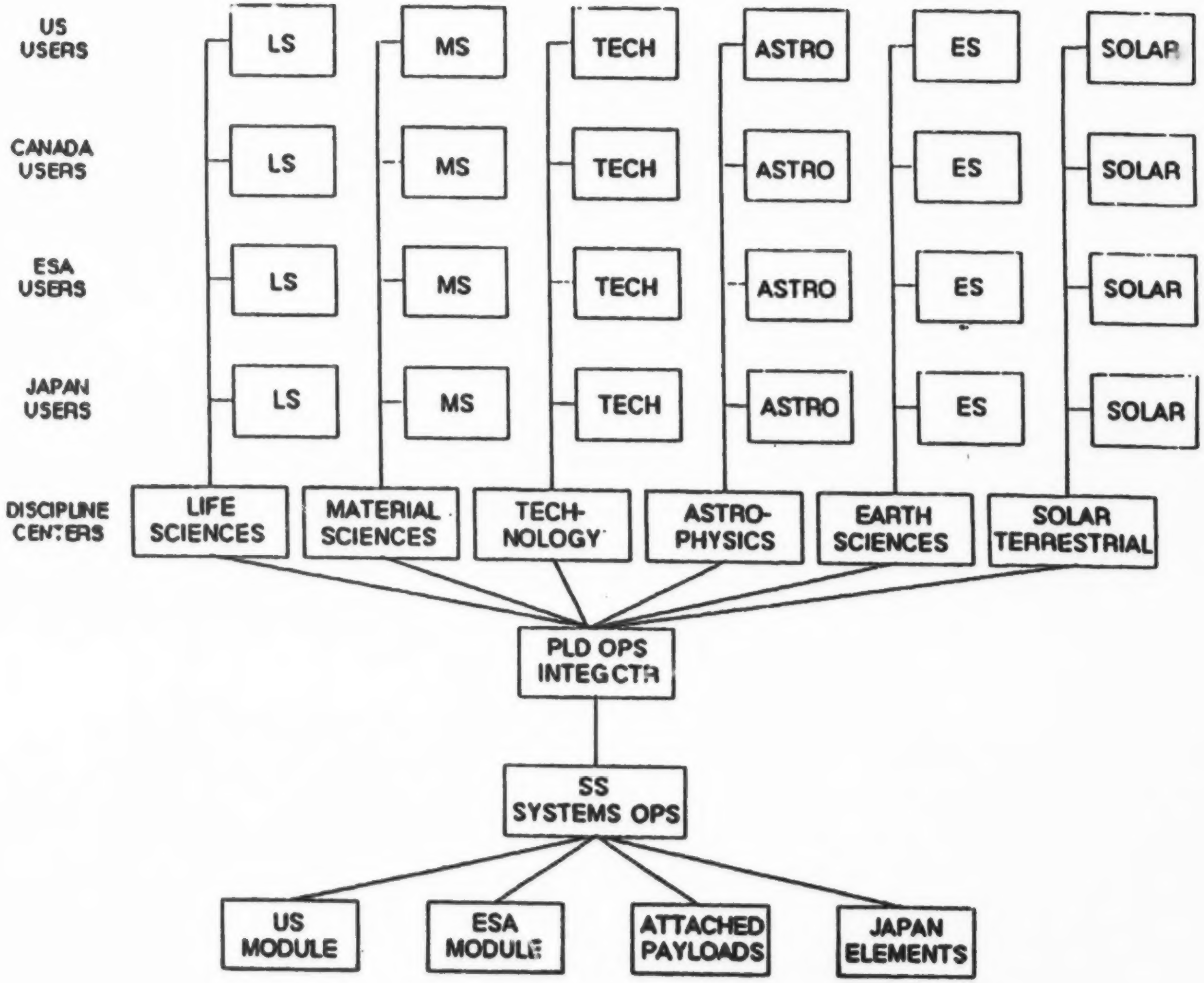

US USERS
CANADA USERS
ESA USERS
JAPAN USERS
DISCIPLINE CENTERS
LS
MS
TECH
ASTRO
ES
SOLAR
LIFE SCIENCES
MATERIAL SCIENCES
TECH-NOLOGY
ASTRO-PHYSICS
EARTH SCIENCES
SOLAR TERRESTRIAL
PLD OPS INTEGCTR
SS SYSTEMS OPS
US MODULE
ESA MODULE
ATTACHED PAYLOADS
JAPAN ELEMENTS

FIGURE 6.2.2-1. DISCIPLINE CENTERS INTEGRATION

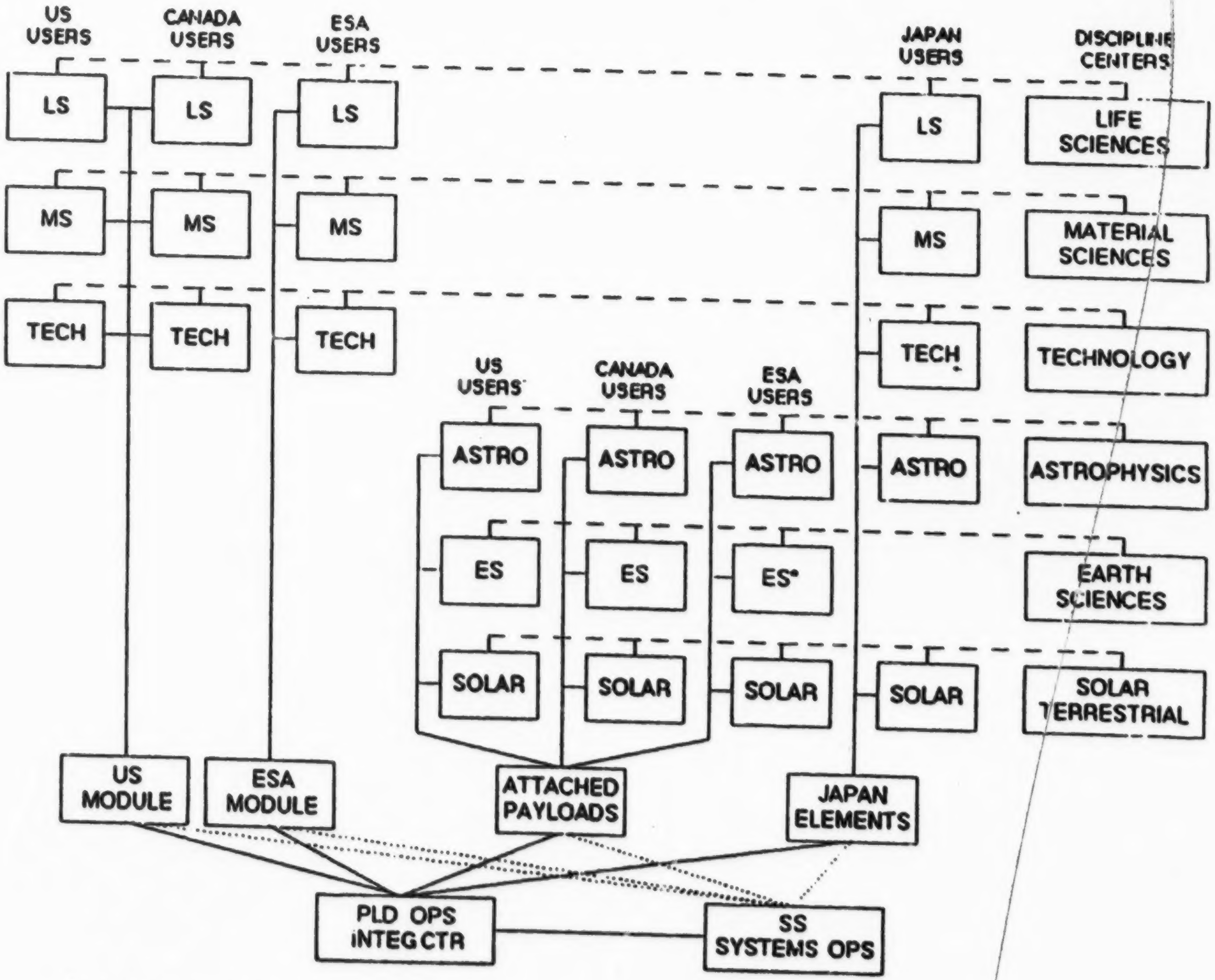

US USERS
CANADA USERS
ESA USERS
JAPAN USERS
DISCIPLINE CENTERS
LS
MS
TECH
LIFE SCIENCES
MATERIAL SCIENCES
TECHNOLOGY
US USERS
CANADA USERS
ESA USERS
ASTRO
ES
ES*
SOLAR
ASTROPHYSICS
EARTH SCIENCES
SOLAR TERRESTRIAL
US MODULE
ESA MODULE
ATTACHED PAYLOADS
JAPAN ELEMENTS
PLD OPS INTEG CTR
SS SYSTEMS OPS

FIGURE 6.2.2-2. ELEMENT CENTERS PRIME INTEGRATION/DISCIPLINE CENTERS INDIRECT

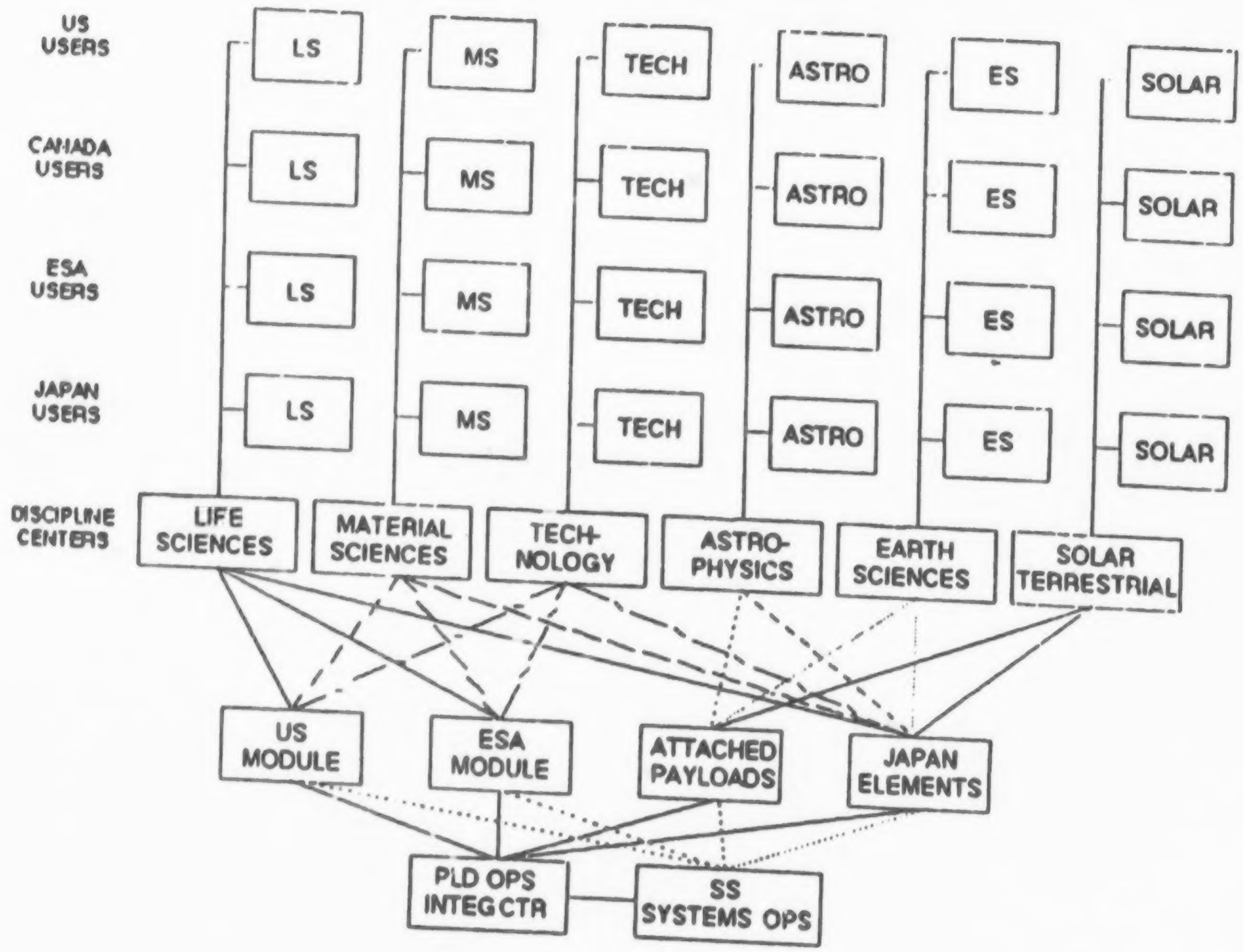

US USERS
CANADA USERS
ESA USERS
JAPAN USERS
DISCIPLINE CENTERS
LS
MS
TECH
ASTRO
ES
SOLAR
LIFE SCIENCES
MATERIAL SCIENCES
TECH-NOLOGY
ASTRO-PHYSICS
EARTH SCIENCES
SOLAR TERRESTRIAL
US MODULE
ESA MODULE
ATTACHED PAYLOADS
JAPAN ELEMENTS
PLD OPS INTEG CTR
SS SYSTEMS OPS

FIGURE 6.2.2-3. DISCIPLINE CENTERS PLUS ELEMENT CENTERS INTEGRATION

6.2.3 SS Payload Mission Planning Process Functional Description

Four distinct high level payload mission planning cycles have been identified as depicted in the Space Station (SS) Payload Mission Planning System (MPS) Top Level Functional Flow, Figure 6.2.3-1.

Cycle A, Define Resource Allocation Envelopes, is necessary for preliminary definition of user resource requirements and integration/approval of these requirements to arrive at agreed upon resource allocations for each experiment entity (single experiment or group of experiments) as well as resource allocations for each planning center.

Cycle B, Generate Tactical Operations Plan (TOP), results in a resource allocation plan for the mission increment that assigns time blocks (resource allocation envelopes) available for each experiment entity within which to schedule detailed operations.

Cycle C, Generate Execution Plans, includes the user activity involved in generating detailed activity and command plans for resource allocation envelopes, plus the activities to integrated those plans. This cycle also results in an integrated payload data flow plan.

Cycle D, Perform Mission Increment Replanning, encompasses similiar activities to Functions B and C. Resources are reallocated; users change detailed activity/command plans; the crew replans activities over which they have control; and all changes are integrated. The data flow plan is finalized and the detailed payload crew activity plans are generated.

A flow of subfunctions for each planning cycle is presented in the flow diagrams designated A, B, C and D. Each of the unique subfunctions appearing on these charts is identified by the number in the upper right hand corner of the flow diagram block. A corresponding flow diagram at the subfunction level is included with the detailed description of each subfunction presented in the following sections.

6.2.3.1 Subfunction 1 - SS Projected Orbit Ephemeris

This subfunction will likely be performed by the Space Station Systems Operations organization. It is included here because the software required to perform this function could be easily derived from the SL MIPS. The basic activity is to generate detailed ephemeris data, such as ascending node data, ground track data and earth shadow on/off times to serve as a basis for subsequent mission planning activities.

6.2.3.2 Subfunction 2 - Standard Orbit Opportunities Generation

This activity may also be performed by the SS Systems Operations organization, but is included here because again SL MIPS software could be utilized with modifications to perform the activity. The basic activity is the generation of standard orbit observation opportunities. An observation opportunity (obs opp) is a particular object or condition that is available as a function of time (on or off). The designation "standard" is made because the obs opps generated during this activity are those that are used by a wide variety of mission planning organizations and scientific disciplines. Grouping these into one subfunction performed by the same organization insures use of common data across all Space Station users and planning centers.

SPACE STATION (SS)
PAYLOAD MISSION PLANNING SYSTEM (MPS)
TOP LEVEL FUNCTIONAL FLOW

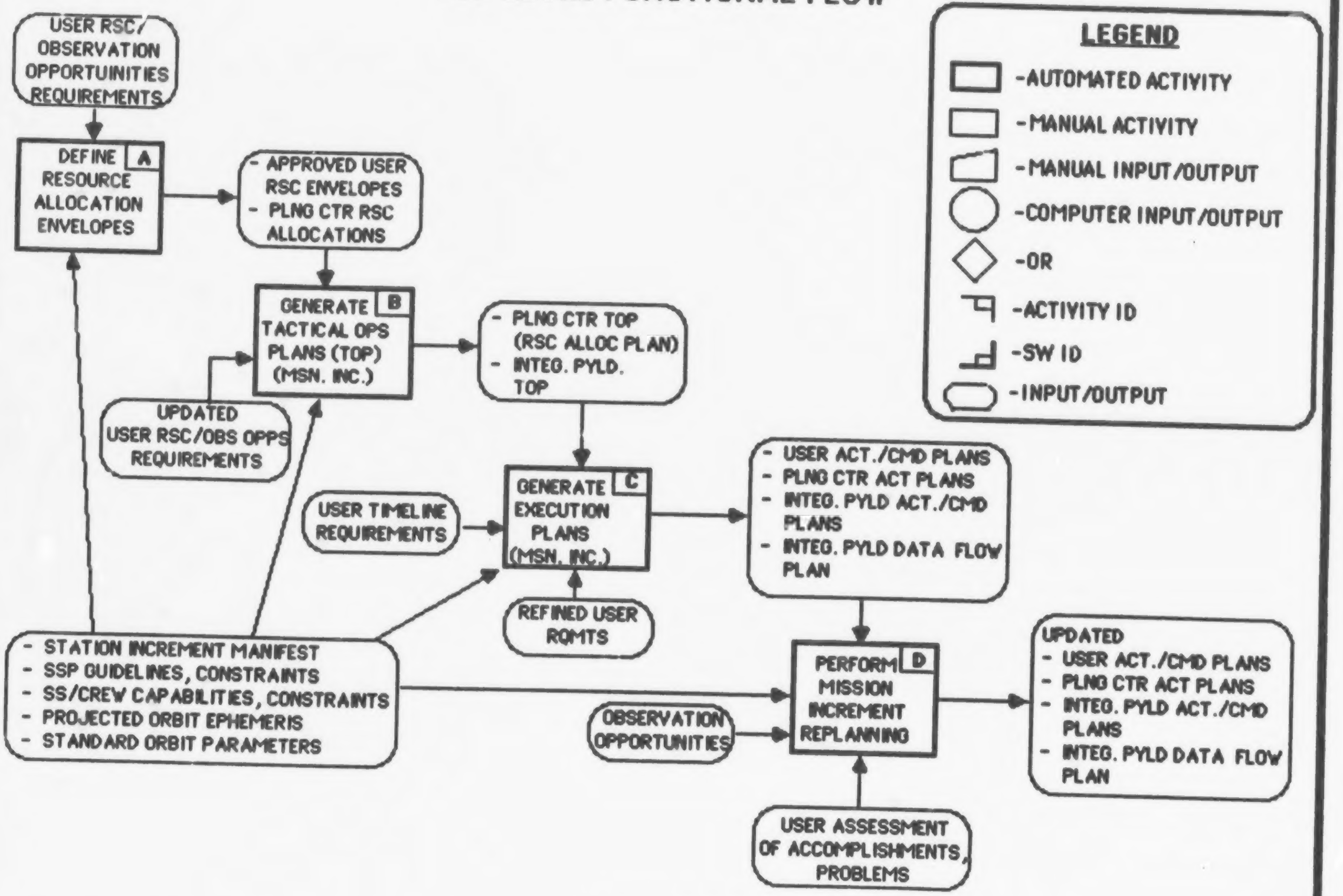
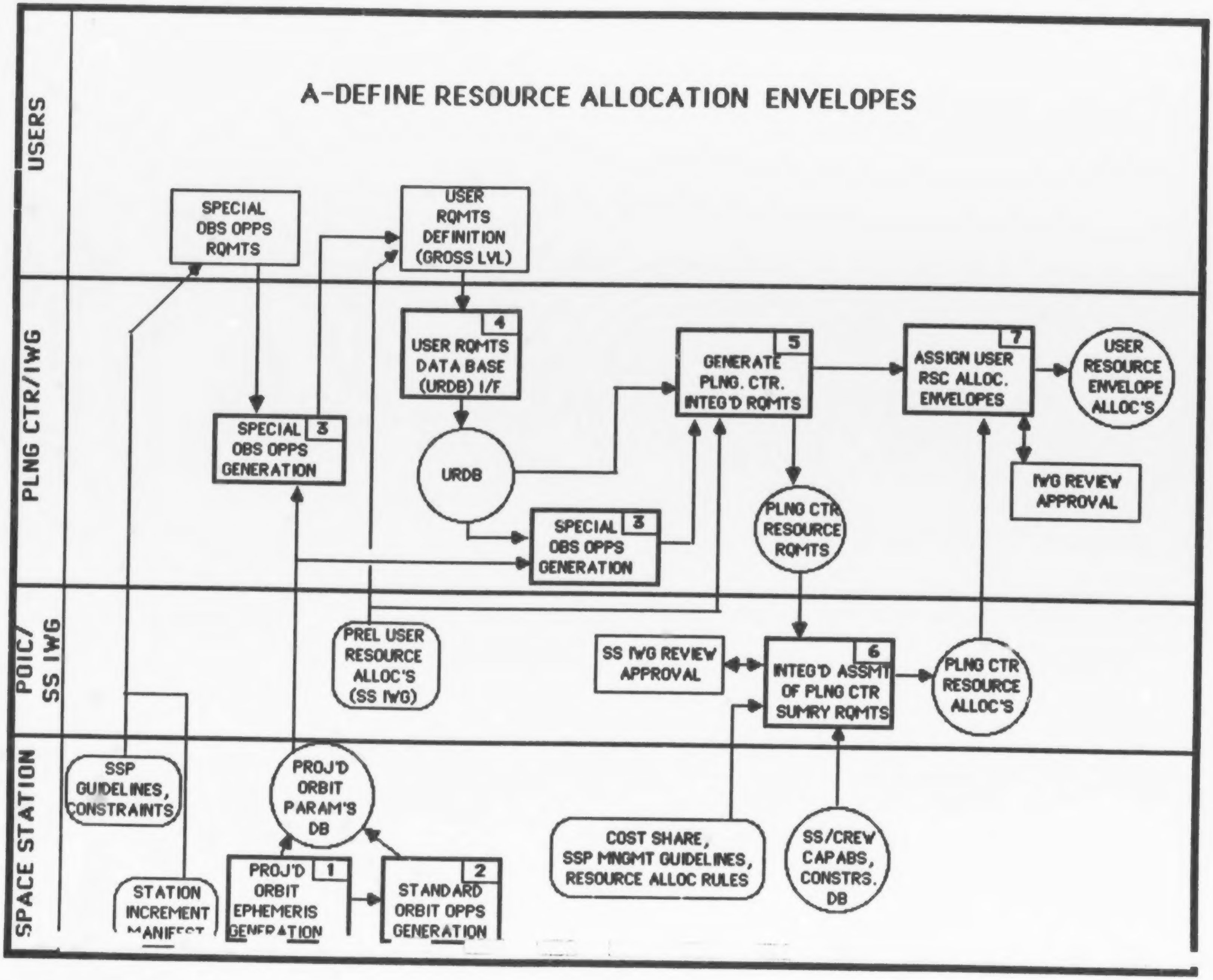
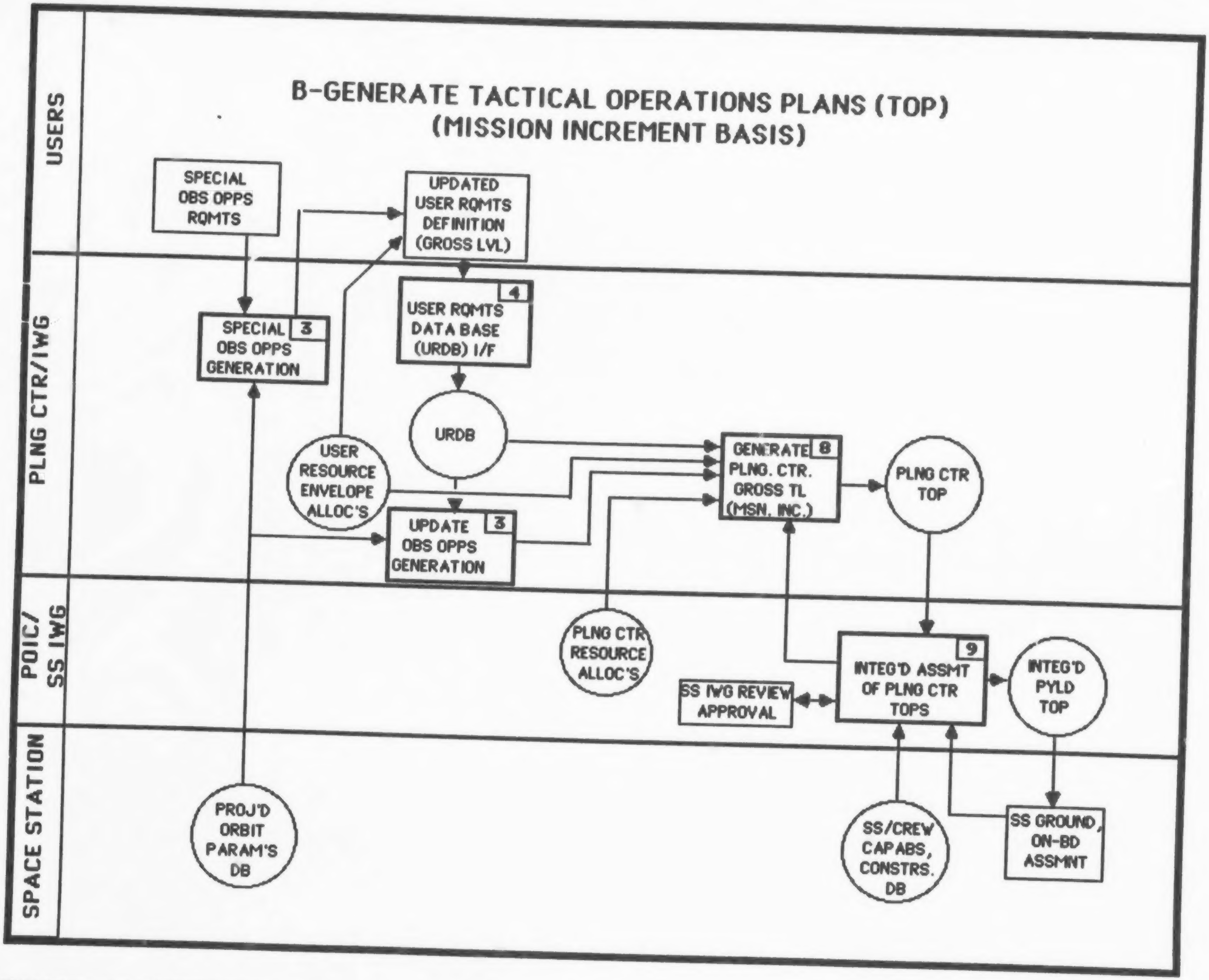

USER RSC/ OBSERVATION OPPORTUINITIES REQUIREMENTS
DEFINE RESOURCE ALLOCATION ENVELOPES
A
- APPROVED USER RSC ENVELOPES
- PLNG CTR RSC ALLOCATIONS
GENERATE TACTICAL OPS PLANS (TOP) (MSN. INC.)
B
UPDATED USER RSC/OBS OPPS REQUIREMENTS
- PLNG CTR TOP (RSC ALLOC PLAN)
- INTEG. PYLD. TOP
USER TIMELINE REQUIREMENTS
GENERATE EXECUTION PLANS (MSN. INC.)
C
REFINED USER RQMTS
- USER ACT./CMD PLANS
- PLNG CTR ACT PLANS
- INTEG. PYLD ACT./CMD PLANS
- INTEG. PYLD DATA FLOW PLAN
- STATION INCREMENT MANIFEST
- SSP GUIDELINES, CONSTRAINTS
- SS/CREW CAPABILITIES, CONSTRAINTS
- PROJECTED ORBIT EPHEMERIS
- STANDARD ORBIT PARAMETERS
OBSERVATION OPPORTUNITIES
PERFORM MISSION INCREMENT REPLANNING
D
USER ASSESSMENT OF ACCOMPLISHMENTS, PROBLEMS
UPDATED
- USER ACT./CMD PLANS
- PLNG CTR ACT PLANS
- INTEG. PYLD ACT./CMD PLANS
- INTEG. PYLD DATA FLOW PLAN
LEGEND
-AUTOMATED ACTIVITY
-MANUAL ACTIVITY
-MANUAL INPUT/OUTPUT
-COMPUTER INPUT/OUTPUT
-OR
-ACTIVITY ID
-SW ID
-INPUT/OUTPUT

FIGURE 6.2.3-1



A-DEFINE RESOURCE ALLOCATION ENVELOPES

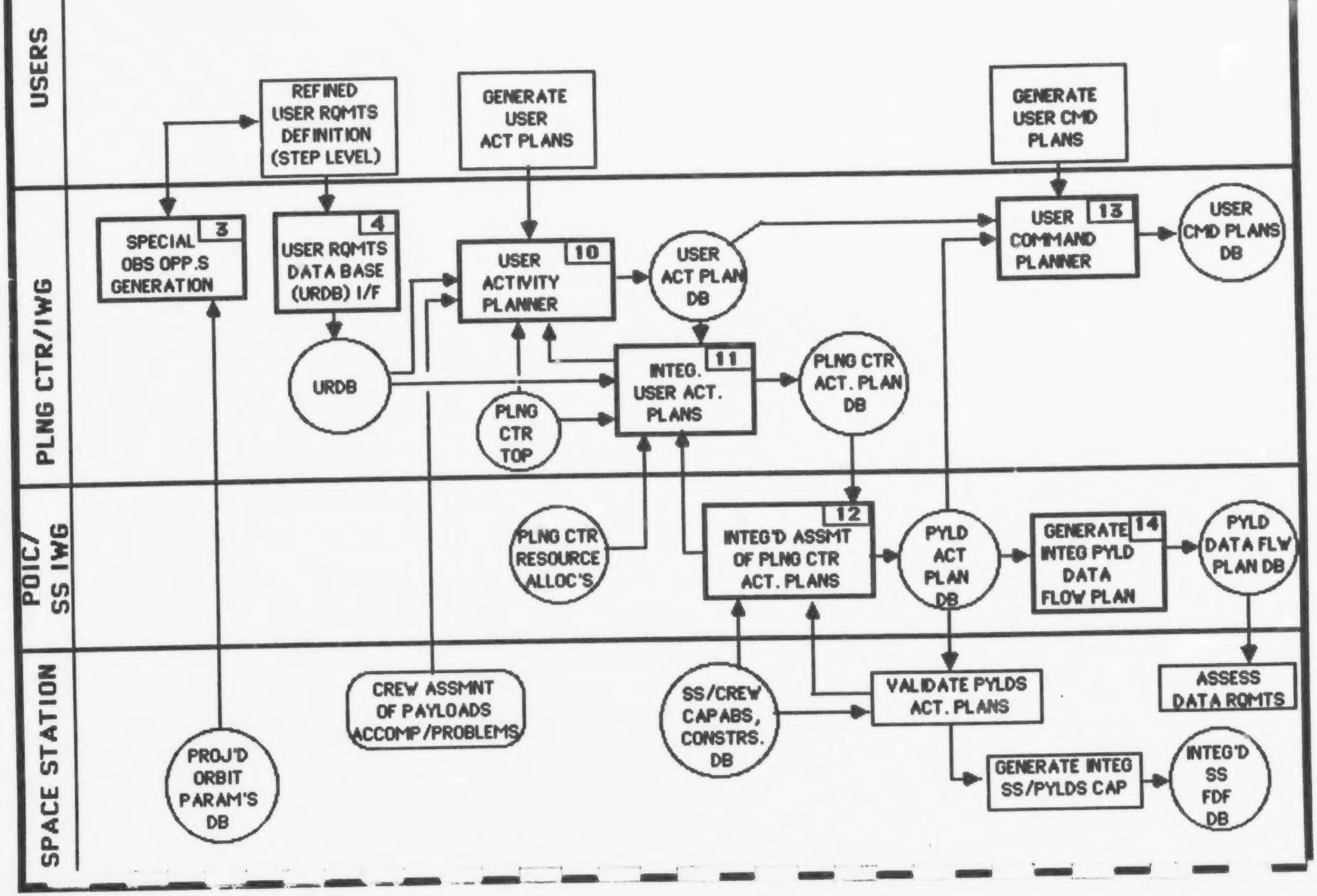
USERS
PLNG CTR/IWG
POIC/ SS IWG
SPACE STATION
SPECIAL OBS OPPS RQMTS
USER RQMTS DEFINITION (GROSS LVL)
4 USER RQMTS DATA BASE (URDB) I/F
URDB
3 SPECIAL OBS OPPS GENERATION
3 SPECIAL OBS OPPS GENERATION
5 GENERATE PLNG. CTR. INTEG'D RQMTS
PLNG CTR RESOURCE RQMTS
7 ASSIGN USER RSC ALLOC. ENVELOPES
USER RESOURCE ENVELOPE ALLOC'S
IWG REVIEW APPROVAL
PREL USER RESOURCE ALLOC'S (SS IWG)
SS IWG REVIEW APPROVAL
6 INTEG'D ASSMT OF PLNG CTR SUMRY RQMTS
PLNG CTR RESOURCE ALLOC'S
SSP GUIDELINES, CONSTRAINTS
STATION INCREMENT MANIFEST
PROJ'D ORBIT PARAM'S DB
1 PROJ'D ORBIT EPHEMERIS GENERATION
2 STANDARD ORBIT OPPS GENERATION
COST SHARE, SSP MNGMT GUIDELINES, RESOURCE ALLOC RULES
SS/CREW CAPABS, CONSTRS. DB

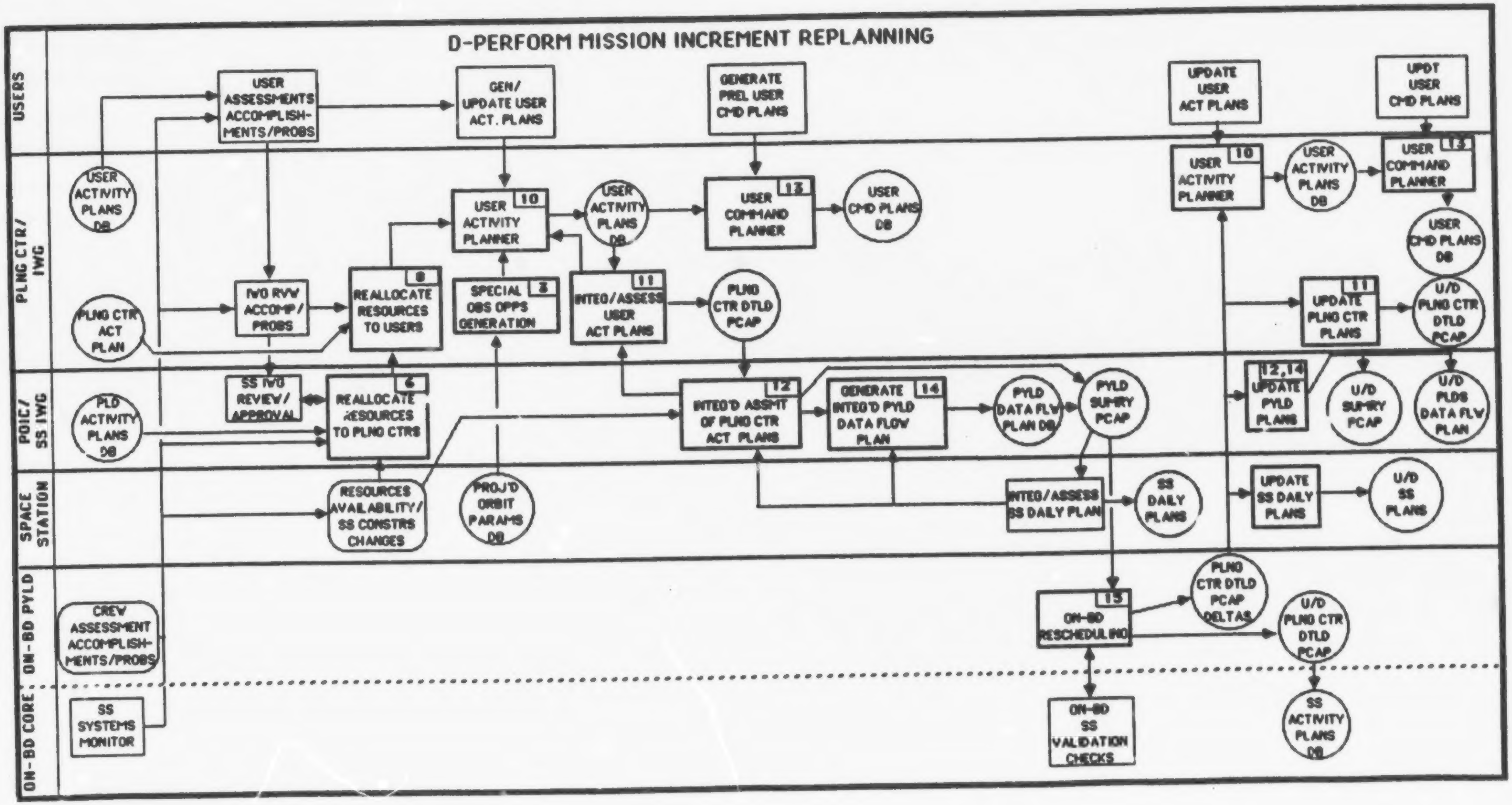


B-GENERATE TACTICAL OPERATIONS PLANS (TOP)
(MISSION INCREMENT BASIS)

USERS
PLNG CTR/IWG
POIC/
SS IWG
SPACE STATION
SPECIAL
OBS OPPS
RQMTS
UPDATED
USER RQMTS
DEFINITION
(GROSS LVL)
SPECIAL
OBS OPPS
GENERATION
3
USER RQMTS
DATA BASE
(URDB) I/F
4
URDB
USER
RESOURCE
ENVELOPE
ALLOC'S
UPDATE
OBS OPPS
GENERATION
3
GENERATE
PLNG. CTR.
GROSS TL
(MSN. INC.)
8
PLNG CTR
TOP
PLNG CTR
RESOURCE
ALLOC'S
INTEG'D ASSMT
OF PLNG CTR
TOPS
9
SS IWG REVIEW
APPROVAL
INTEG'D
PYLD
TOP
PROJ'D
ORBIT
PARAM'S
DB
SS/CREW
CAPABS,
CONSTRS.
DB
SS GROUND,
ON-BD
ASSMNT

C-GENERATE EXECUTION PLANS
(MISSION INCREMENT)

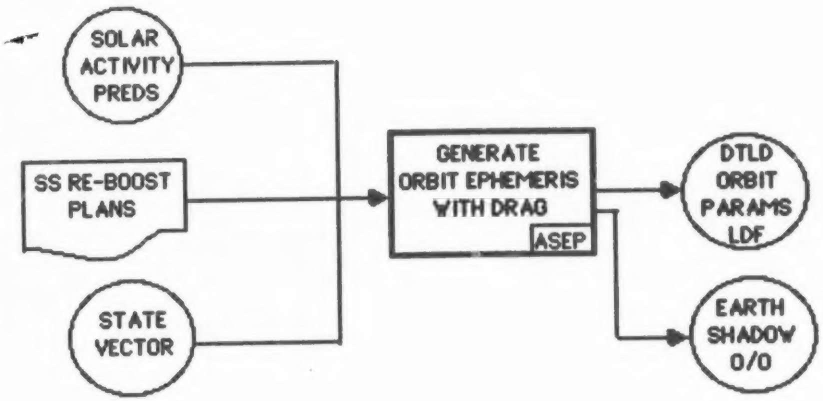

USERS
PLNG CTR/IWG
POIC/ SS IWG
SPACE STATION
REFINED USER RQMTS DEFINITION (STEP LEVEL)
GENERATE USER ACT PLANS
GENERATE USER CMD PLANS
SPECIAL OBS OPP.S GENERATION 3
USER RQMTS DATA BASE (URDB) I/F 4
USER ACTIVITY PLANNER 10
USER ACT PLAN DB
USER COMMAND PLANNER 13
USER CMD PLANS DB
URDB
PLNG CTR TOP
INTEG. USER ACT. PLANS 11
PLNG CTR ACT. PLAN DB
PLNG CTR RESOURCE ALLOC'S
INTEG'D ASSMT OF PLNG CTR ACT. PLANS 12
PYLD ACT PLAN DB
GENERATE INTEG PYLD DATA FLOW PLAN 14
PYLD DATA FLW PLAN DB
CREW ASSMNT OF PAYLOADS ACCOMP/PROBLEMS
SS/CREW CAPABS, CONSTRS. DB
VALIDATE PYLDS ACT. PLANS
ASSESS DATA RQMTS
PROJ'D ORBIT PARAM'S DB
GENERATE INTEG SS/PYLDS CAP
INTEG'D SS FDF DB



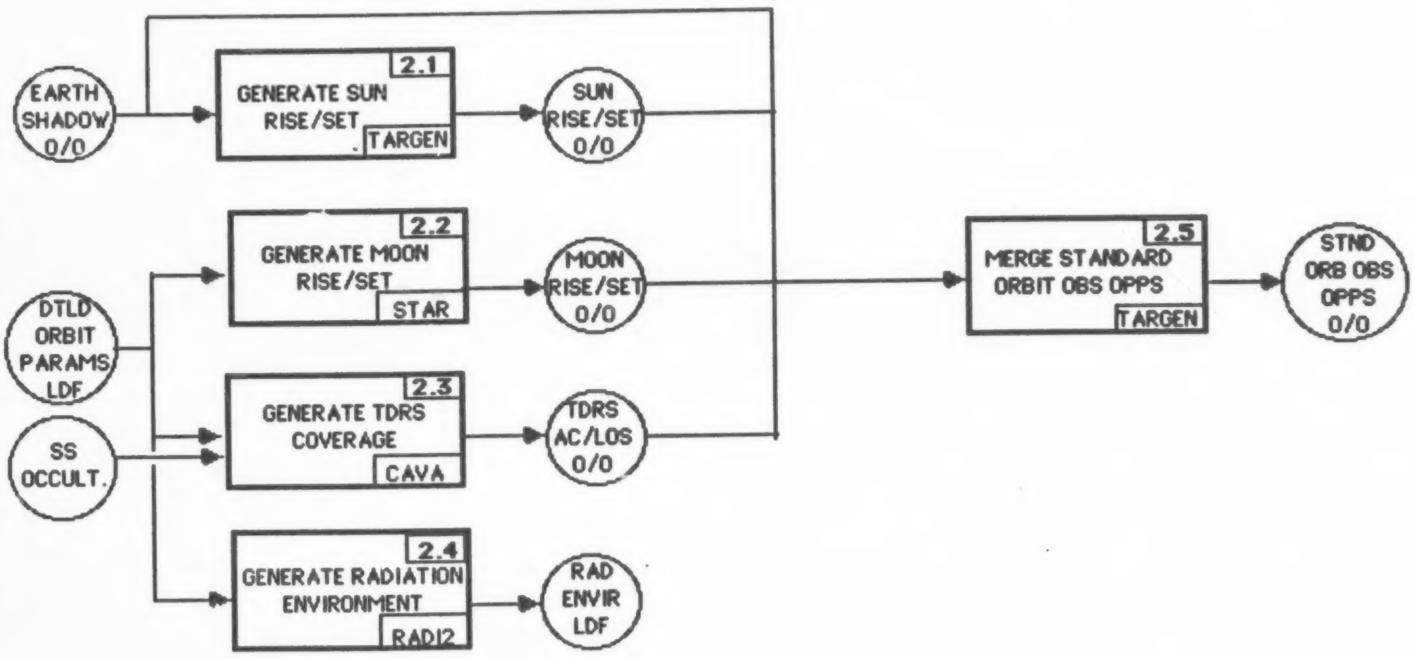
D-PERFORM MISSION INCREMENT REPLANNING

USERS
PLNG CTR/ IWG
POIC/ SS IWG
SPACE STATION
ON-BD PYLD
ON-BD CORE
USER ASSESSMENTS ACCOMPLISHMENTS/PROBS
GEN/ UPDATE USER ACT. PLANS
GENERATE PREL USER CMD PLANS
UPDATE USER ACT PLANS
UPDT USER CMD PLANS
USER ACTIVITY PLANS DB
PLNG CTR ACT PLAN
IVO RVW ACCOMP/ PROBS
8 REALLOCATE RESOURCES TO USERS
10 USER ACTIVITY PLANNER
3 SPECIAL OBS OPPS GENERATION
11 INTEG/ASSESS USER ACT PLANS
13 USER COMMAND PLANNER
USER CMD PLANS DB
PLNG CTR DTLD PCAP
11 UPDATE PLNG CTR PLANS
U/D PLNG CTR DTLD PCAP
PLD ACTIVITY PLANS DB
SS IVO REVIEW/ APPROVAL
6 REALLOCATE RESOURCES TO PLNG CTRS
12 INTEG'D ASSMT OF PLNG CTR ACT PLANS
14 GENERATE INTEG'D PYLD DATA FLOW PLAN
PYLD DATA FLW PLAN DB
PYLD SUMRY PCAP
12,14 UPDATE PYLD PLANS
U/D SUMRY PCAP
U/D PLDS DATA FLW PLAN
RESOURCES AVAILABILITY/ SS CONSTRS CHANGES
PROJ'D ORBIT PARAMS DB
INTEG/ASSESS SS DAILY PLAN
SS DAILY PLANS
UPDATE SS DAILY PLANS
U/D SS PLANS
CREW ASSESSMENT ACCOMPLISHMENTS/PROBS
SS SYSTEMS MONITOR
15 ON-BD RESCHEDULING
PLNG CTR DTLD PCAP DELTAS
U/D PLNG CTR DTLD PCAP
ON-BD SS VALIDATION CHECKS
SS ACTIVITY PLANS DB

SUBFUNCTION: 1-SS PROJECTED ORBIT EPHEMERIS GENERATION


SOLAR ACTIVITY PREDS
SS RE-BOOST PLANS
STATE VECTOR
GENERATE ORBIT EPHEMERIS WITH DRAG
ASEP
DTLD ORBIT PARAMS LDF
EARTH SHADOW O/O

SUBFUNCTION: 2-STANDARD ORBIT OPPORTUNITIES GENERATION


EARTH SHADOW 0/0
DTLD ORBIT PARAMS LDF
SS OCCULT.
2.1
GENERATE SUN RISE/SET
TARGEN
2.2
GENERATE MOON RISE/SET
STAR
2.3
GENERATE TDRS COVERAGE
CAVA
2.4
GENERATE RADIATION ENVIRONMENT
RADI2
SUN RISE/SET 0/0
MOON RISE/SET 0/0
TDRS AC/LOS 0/0
RAD ENVIR LDF
2.5
MERGE STANDARD ORBIT OBS OPPS
TARGEN
STND ORB OBS OPPS 0/0

6.2.3.3 Subfunction 3 - Special Observation Opportunities Generation

This activity involves generation of the observation opportunities that are discipline dependent. It is expanded into task level flow diagrams corresponding to the identified disciplines. Each of these tasks includes the detailed activities required to generate the specific obs opps for each discipline. In practice, this activity will be performed by both SS users and the planning centers. The users will perform analyses to determine when they want to operate and which obs opps they want to utilize. Planning center personnel will access all users obs opps requirements entered in the User Requirements Data Base (URDB) and generate an integrated planning center set of obs opps to serve as input for subsequent mission planning tasks.

6.2.3.4 Subfunction 4 - User Requirements Definition and Data Base (URDB) Interface

This activity includes user interactive input/editing of a data base that contains resources, obs opps, sequencing/concurrency and number of performances/duration requirements as well as operational constraints for each individual experiment entity. An entity can be a single experiment or a group of experiments. Depending on experiment resource profiles, a particular experiment will have from one to many resource envelopes. User friendliness and scheduling complexity as well as resource utilization efficiency will be significant factors in determining the characteristics of the resource profiles.

6.2.3.5 Subfunction 5 - Generate Planning Center Integrated Requirements

User requirements are summarized in a gross scheduling activity based on the URDB entries and the observation opportunities file. No resource checking is performed during scheduling. The output schedule(s) are used to determine the overall planning center resource requirements.

6.2.3.6 Subfunction 6 - Integrated Assessment Of Planning Center Summary Requirements

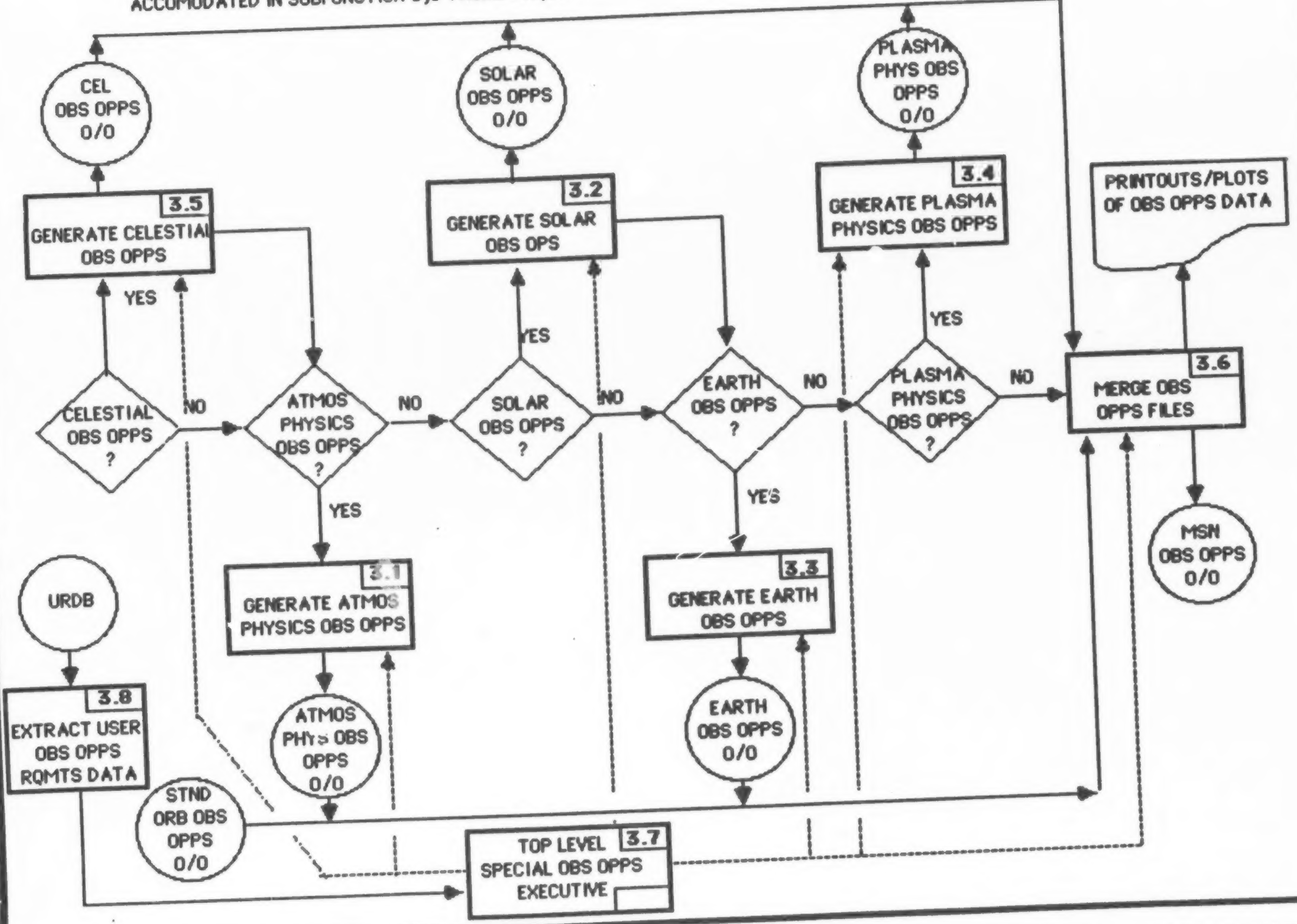
Planning center resource requirements, SSP management guidelines, resource allocation rules, user group guidance and element design constraints are utilized as inputs to assign each planning center a specific set of resource allocations.

6.2.3.7 Subfunction 7 - Assign User Resource Allocation Envelopes

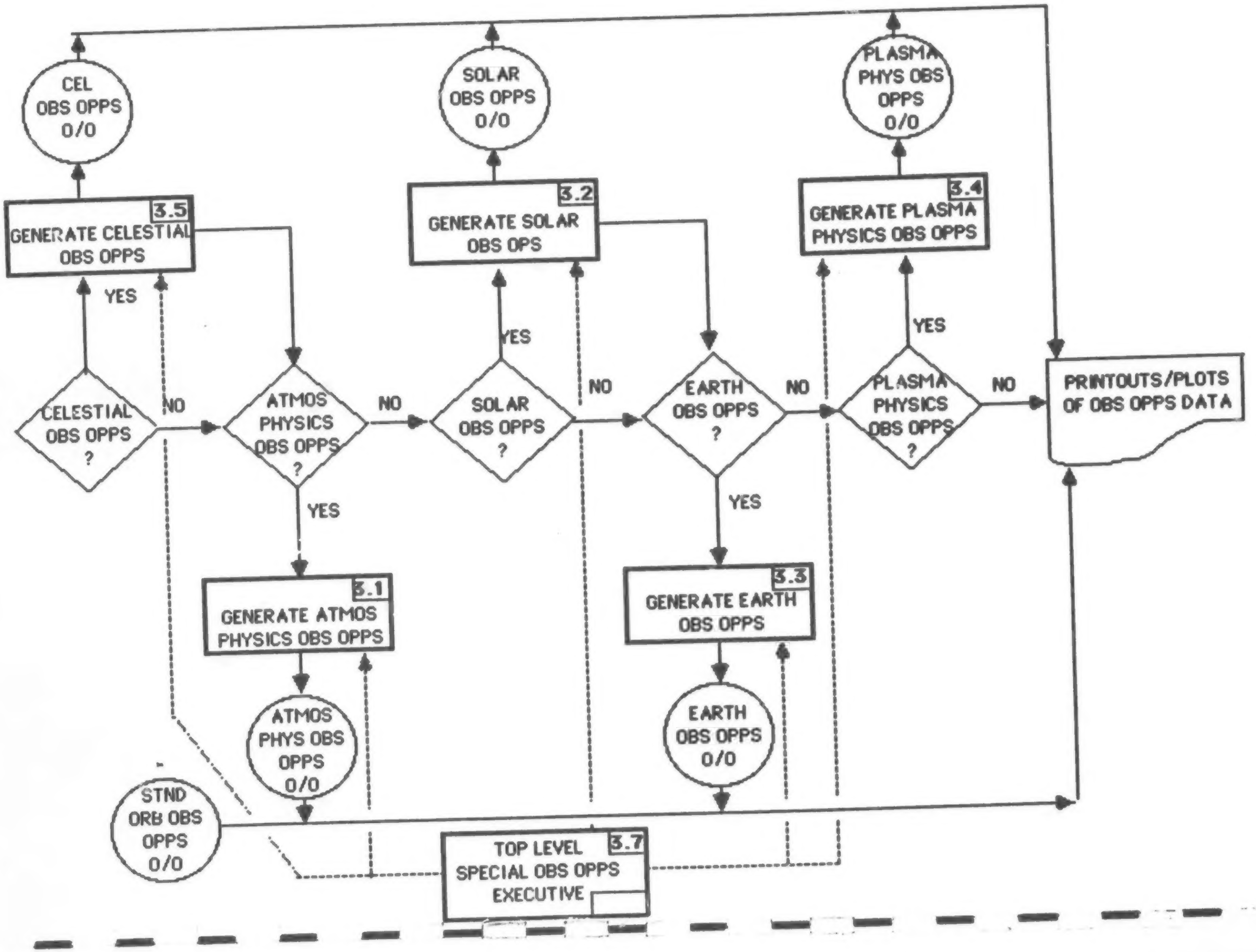
This activity is basically a formal approval process of each users URDB entries. There may be cases where user resource requirements are incompatible with those available to the planning center when considering other manifested users. These cases must be treated separately and will require reduction of user resource requests (redesign, reduced objectives, etc.) or an appeal through channels for increased planning center resource allocations. A thorough compatibility analysis of preliminary user requirements in the strategic level planning/manifesting process should reduce the potential for conflicts at this point.

SUBFUNCTION: 3(PLNG CTR)-SPECIAL OBSERVATION OPPORTUNITIES GENERATION

NOTE: THE MISSION OBSERVATION OPPORTUNITIES GENERATED BY THIS SUBFUNCTION ARE BASED ON PROJECTED SS ORBITAL POSITION AND/OR ENVIRONMENTAL CONDITIONS. USER RQMTS FOR OBSERVATIONS THAT ARE STRICTLY TIME PREFERENCES ARE ACCOMODATED IN SUBFUNCTION 5,8 TASKS 5.1,8.1.

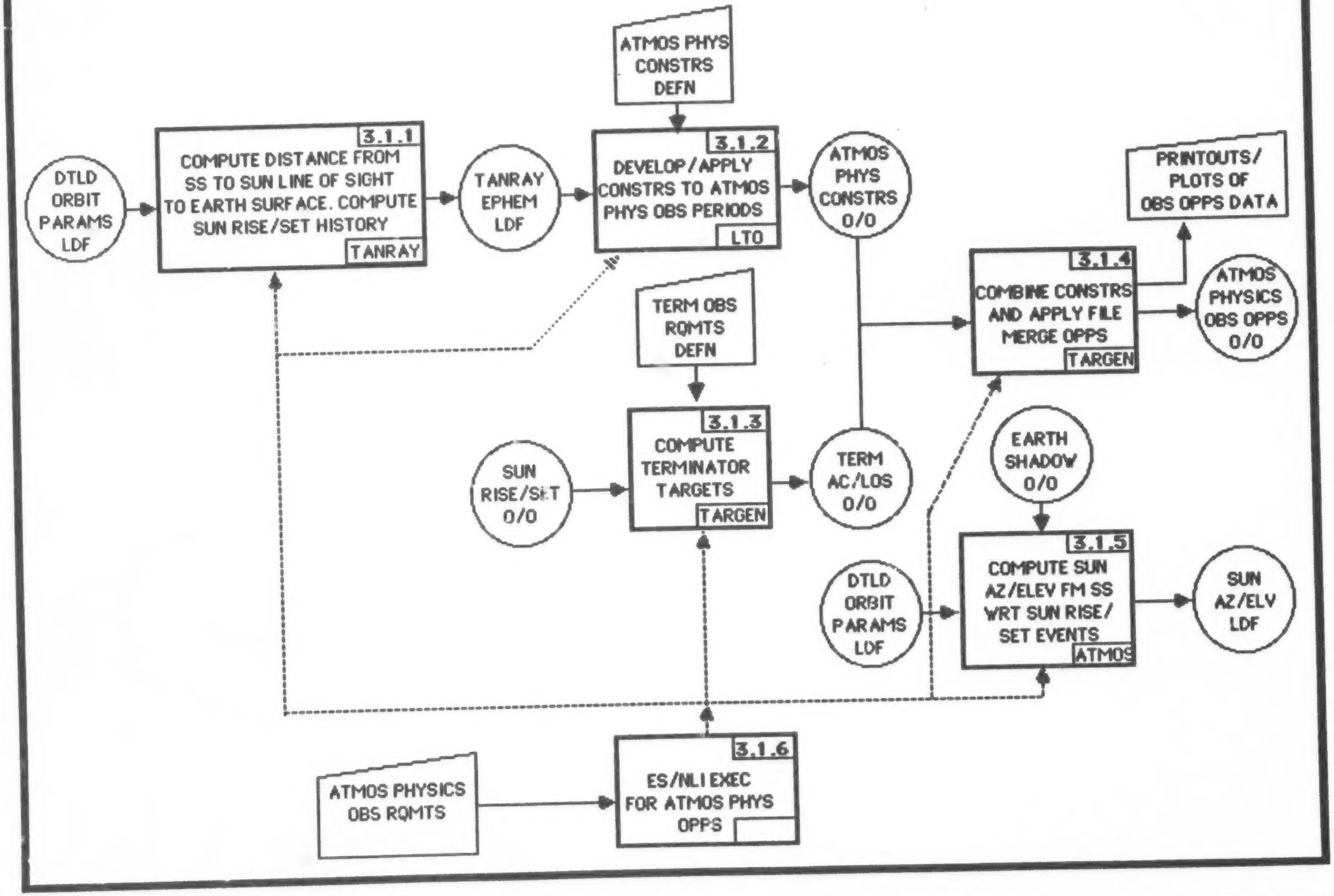

CEL OBS OPPS 0/0
3.5
GENERATE CELESTIAL OBS OPPS
YES
CELESTIAL OBS OPPS ?
NO
ATMOS PHYSICS OBS OPPS ?
YES
3.1
GENERATE ATMOS PHYSICS OBS OPPS
ATMOS PHYS OBS OPPS 0/0
NO
SOLAR OBS OPPS 0/0
3.2
GENERATE SOLAR OBS OPS
YES
SOLAR OBS OPPS ?
NO
EARTH OBS OPPS ?
YES
3.3
GENERATE EARTH OBS OPPS
EARTH OBS OPPS 0/0
NO
PLASMA PHYS OBS OPPS 0/0
3.4
GENERATE PLASMA PHYSICS OBS OPPS
YES
PLASMA PHYSICS OBS OPPS ?
NO
PRINTOUTS/PLOTS OF OBS OPPS DATA
3.6
MERGE OBS OPPS FILES
MSN OBS OPPS 0/0
URDB
3.8
EXTRACT USER OBS OPPS RQMTS DATA
STND ORB OBS OPPS 0/0
TOP LEVEL
3.7
SPECIAL OBS OPPS EXECUTIVE

SUBFUNCTION: 3(USER)-SPECIAL OBSERVATION OPPORTUNITIES GENERATION


CEL OBS OPPS 0/0
3.5
GENERATE CELESTIAL OBS OPPS
YES
CELESTIAL OBS OPPS ?
NO
ATMOS PHYSICS OBS OPPS ?
YES
3.1
GENERATE ATMOS PHYSICS OBS OPPS
ATMOS PHYS OBS OPPS 0/0
NO
SOLAR OBS OPPS 0/0
3.2
GENERATE SOLAR OBS OPS
YES
SOLAR OBS OPPS ?
NO
EARTH OBS OPPS ?
YES
3.3
GENERATE EARTH OBS OPPS
EARTH OBS OPPS 0/0
NO
PLASMA PHYS OBS OPPS 0/0
3.4
GENERATE PLASMA PHYSICS OBS OPPS
YES
PLASMA PHYSICS OBS OPPS ?
NO
PRINTOUTS/PLOTS OF OBS OPPS DATA
STND ORB OBS OPPS 0/0
3.7
TOP LEVEL SPECIAL OBS OPPS EXECUTIVE

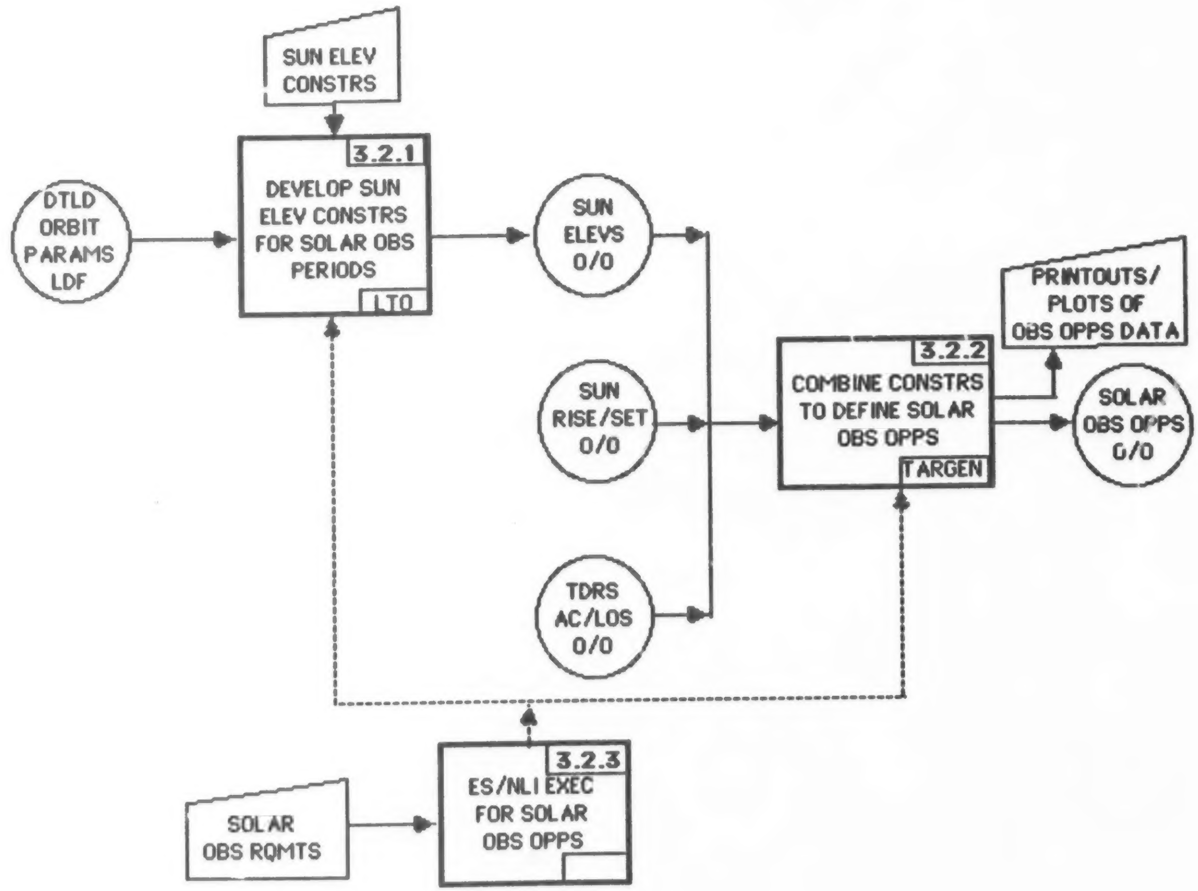
SUBFUNCTION: 3-SPECIAL OBSERVATIONS OPPORTUNITIES GENERATION

TASK: 3.1-GENERATE ATMOSPHERIC PHYSICS OBSERVATION OPPORTUNITIES


DTLD ORBIT PARAMS LDF
3.1.1
COMPUTE DISTANCE FROM SS TO SUN LINE OF SIGHT TO EARTH SURFACE. COMPUTE SUN RISE/SET HISTORY
TANRAY
TANRAY EPHEM LDF
ATMOS PHYS CONSTRS DEFN
3.1.2
DEVELOP/APPLY CONSTRS TO ATMOS PHYS OBS PERIODS
LTO
ATMOS PHYS CONSTRS 0/0
PRINTOUTS/ PLOTS OF OBS OPPS DATA
3.1.4
COMBINE CONSTRS AND APPLY FILE MERGE OPPS
TARGEN
ATMOS PHYSICS OBS OPPS 0/0
TERM OBS RQMTS DEFN
3.1.3
COMPUTE TERMINATOR TARGETS
TARGEN
SUN RISE/SET 0/0
TERM AC/LOS 0/0
EARTH SHADOW 0/0
DTLD ORBIT PARAMS LDF
3.1.5
COMPUTE SUN AZ/ELEV FM SS WRT SUN RISE/ SET EVENTS
ATMOS
SUN AZ/ELV LDF
ATMOS PHYSICS OBS RQMTS
3.1.6
ES/NLI EXEC FOR ATMOS PHYS OPPS

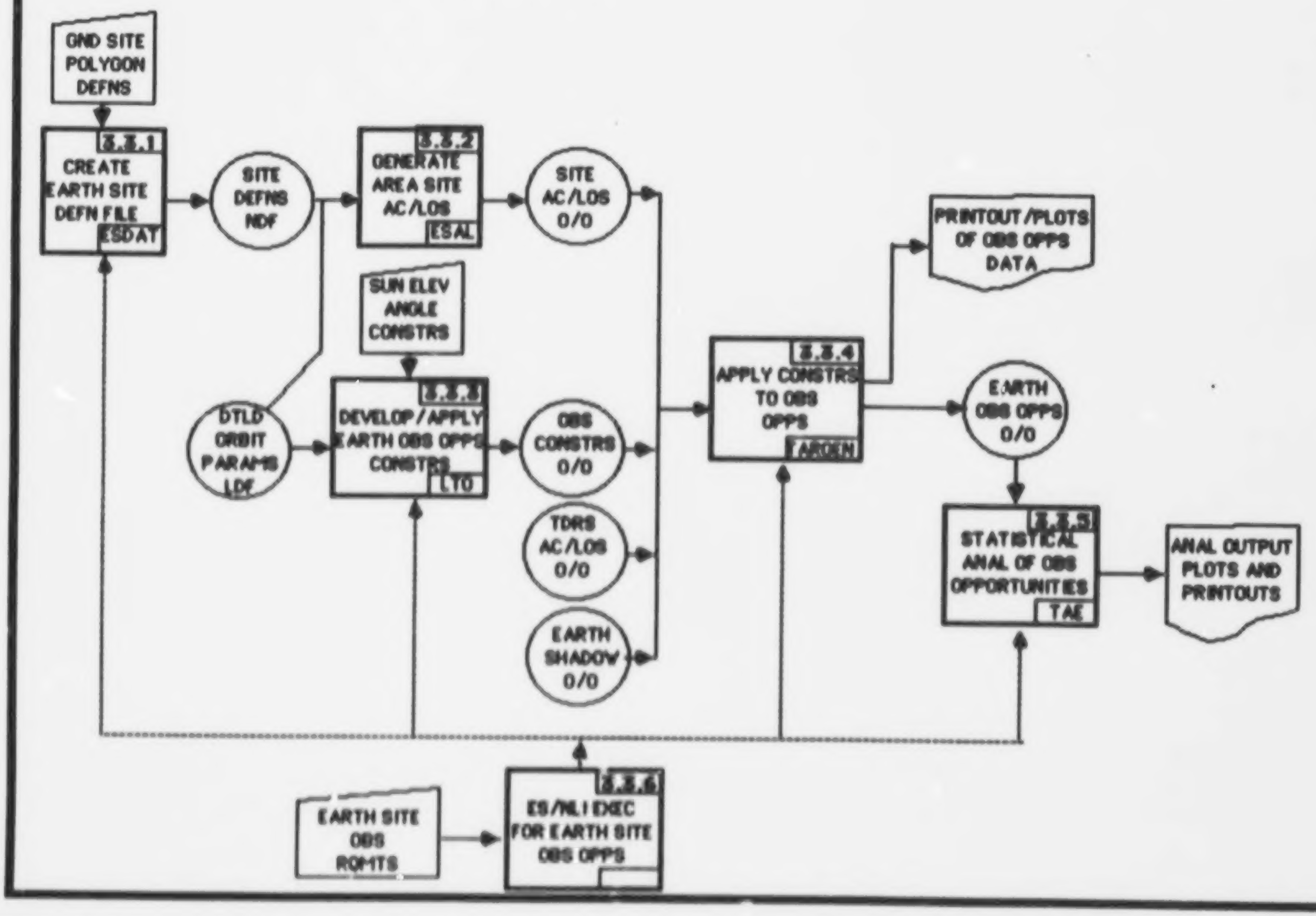
SUBFUNCTION: SPECIAL OBSERVATION OPPORTUNITIES GENERATION

TASK: 3.2-GENERATE SOLAR OBSERVATION OPPORTUNITIES


SUN ELEV CONSTRS
3.2.1
DEVELOP SUN ELEV CONSTRS FOR SOLAR OBS PERIODS
LTO
DTLD ORBIT PARAMS LDF
SUN ELEVS 0/0
SUN RISE/SET 0/0
TDRS AC/LOS 0/0
3.2.2
COMBINE CONSTRS TO DEFINE SOLAR OBS OPPS
TARGEN
PRINTOUTS/ PLOTS OF OBS OPPS DATA
SOLAR OBS OPPS 0/0
3.2.3
ES/NLI EXEC FOR SOLAR OBS OPPS
SOLAR OBS RQMTS

SUBFUNCTION: 3-SPECIAL OBSERVATION OPPORTUNITIES GENERATION

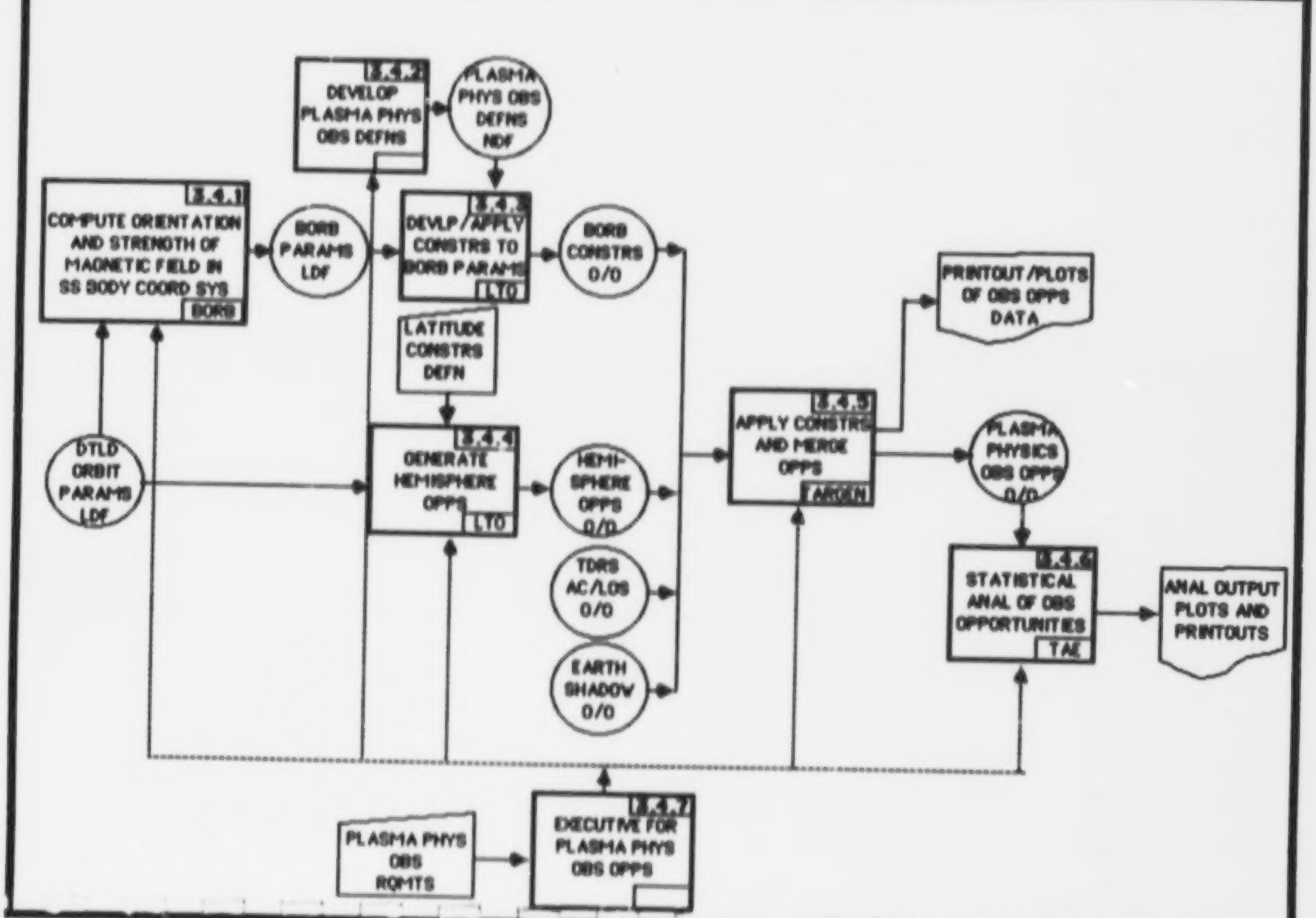
TASK: 3.3-GENERATE EARTH SITE OBSERVATION OPPORTUNITIES


GND SITE POLYGON DEFNS
3.3.1
CREATE EARTH SITE DEFN FILE
ESDAT
SITE DEFNS NDF
3.3.2
GENERATE AREA SITE AC/LOS
ESAL
SITE AC/LOS 0/0
SUN ELEV ANGLE CONSTRS
DTLD ORBIT PARAMS LDF
3.3.3
DEVELOP/APPLY EARTH OBS OPPS CONSTRS
LTO
OBS CONSTRS 0/0
TDRS AC/LOS 0/0
EARTH SHADOW 0/0
3.3.4
APPLY CONSTRS TO OBS OPPS
FARDEN
PRINTOUT/PLOTS OF OBS OPPS DATA
EARTH OBS OPPS 0/0
3.3.5
STATISTICAL ANAL OF OBS OPPORTUNITIES
TAE
ANAL OUTPUT PLOTS AND PRINTOUTS
EARTH SITE OBS RQMTS
3.3.6
ES/NLI EXEC FOR EARTH SITE OBS OPPS

C-2

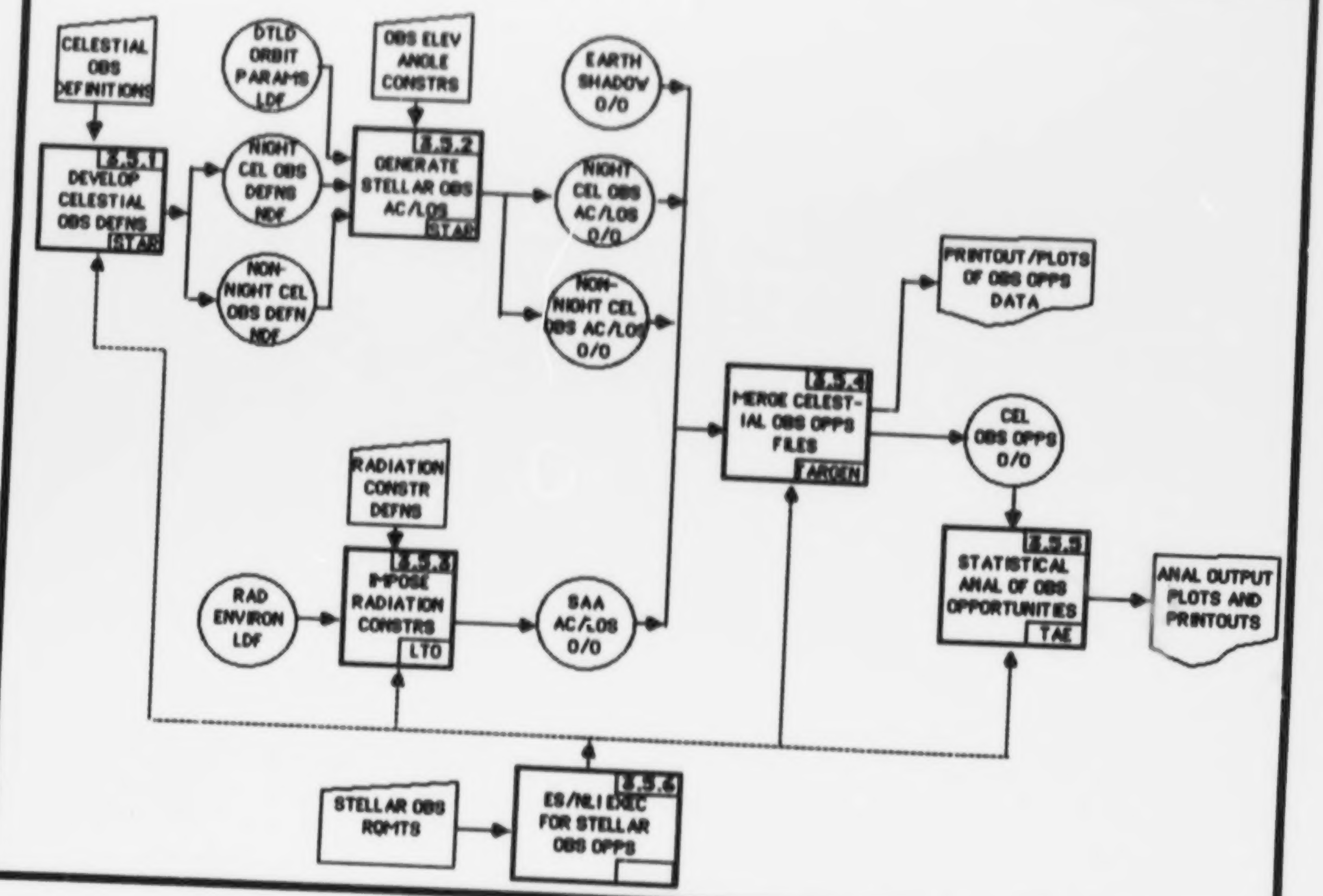
SUBFUNCTION: 3-SPECIAL OBSERVATION OPPORTUNITIES GENERATION

TASK: 3.4-GENERATE PLASMA PHYSICS OBSERVATION OPPORTUNITIES


3.4.1
COMPUTE ORIENTATION AND STRENGTH OF MAGNETIC FIELD IN SS BODY COORD SYS
BORB
BORB PARAMS LDF
3.4.2
DEVELOP PLASMA PHYS OBS DEFNS
PLASMA PHYS OBS DEFNS NDF
3.4.3
DEVLP/APPLY CONSTRS TO BORB PARAMS
LTO
BORB CONSTRS 0/0
LATITUDE CONSTRS DEFN
DTLD ORBIT PARAMS LDF
3.4.4
GENERATE HEMISPHERE OPPS
LTO
HEMI-SPHERE OPPS 0/0
TDRS AC/LOS 0/0
EARTH SHADOW 0/0
3.4.5
APPLY CONSTRS AND MERGE OPPS
TARGEN
PRINTOUT/PLOTS OF OBS OPPS DATA
PLASMA PHYSICS OBS OPPS 0/0
3.4.6
STATISTICAL ANAL OF OBS OPPORTUNITIES
TAE
ANAL OUTPUT PLOTS AND PRINTOUTS
PLASMA PHYS OBS RQMTS
3.4.7
EXECUTIVE FOR PLASMA PHYS OBS OPPS

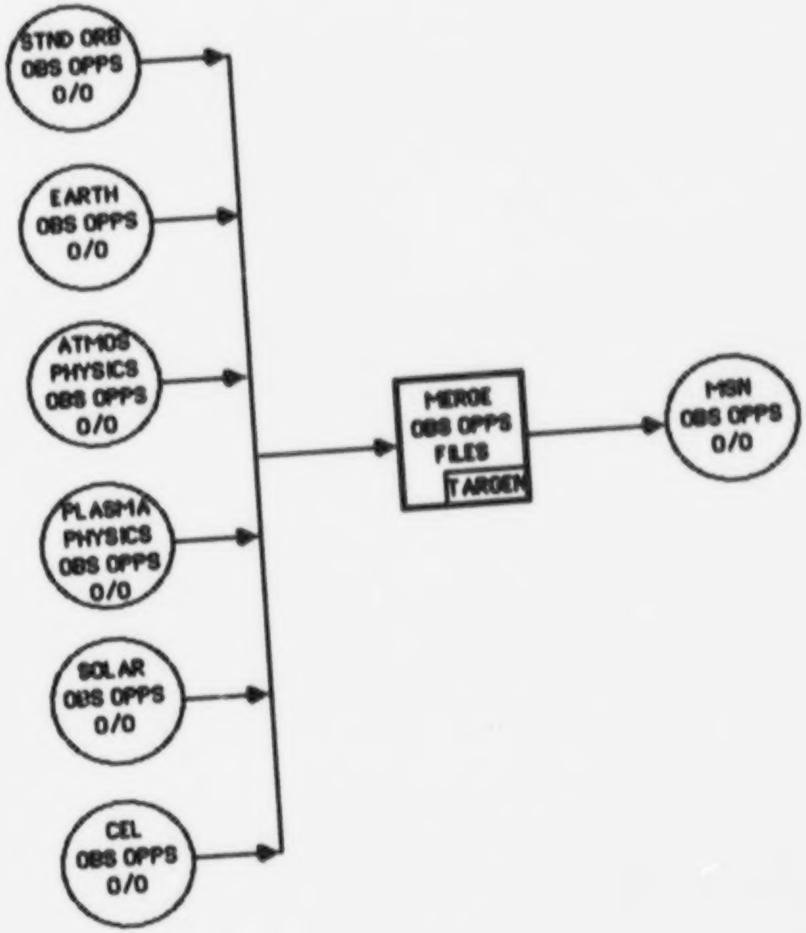
SUBFUNCTION: 3-SPECIAL OBSERVATION OPPORTUNITIES GENERATION

TASK: 3.5-GENERATE CELESTIAL OBSERVATION OPPORTUNITIES


CELESTIAL OBS DEFINITIONS
3.5.1
DEVELOP CELESTIAL OBS DEFNS
STAR
DTLD ORBIT PARAMS LDF
NIGHT CEL OBS DEFNS NDF
NON-NIGHT CEL OBS DEFN NDF
OBS ELEV ANGLE CONSTRS
3.5.2
GENERATE STELLAR OBS AC/LOS
STAR
EARTH SHADOW 0/0
NIGHT CEL OBS AC/LOS 0/0
NON-NIGHT CEL OBS AC/LOS 0/0
RADIATION CONSTR DEFNS
RAD ENVIRON LDF
3.5.3
IMPOSE RADIATION CONSTRS
LTO
SAA AC/LOS 0/0
3.5.4
MERGE CELESTIAL OBS OPPS FILES
FARGEN
PRINTOUT/PLOTS OF OBS OPPS DATA
CEL OBS OPPS 0/0
3.5.5
STATISTICAL ANAL OF OBS OPPORTUNITIES
TAE
ANAL OUTPUT PLOTS AND PRINTOUTS
STELLAR OBS RQMTS
3.5.6
ES/NLI EXEC FOR STELLAR OBS OPPS

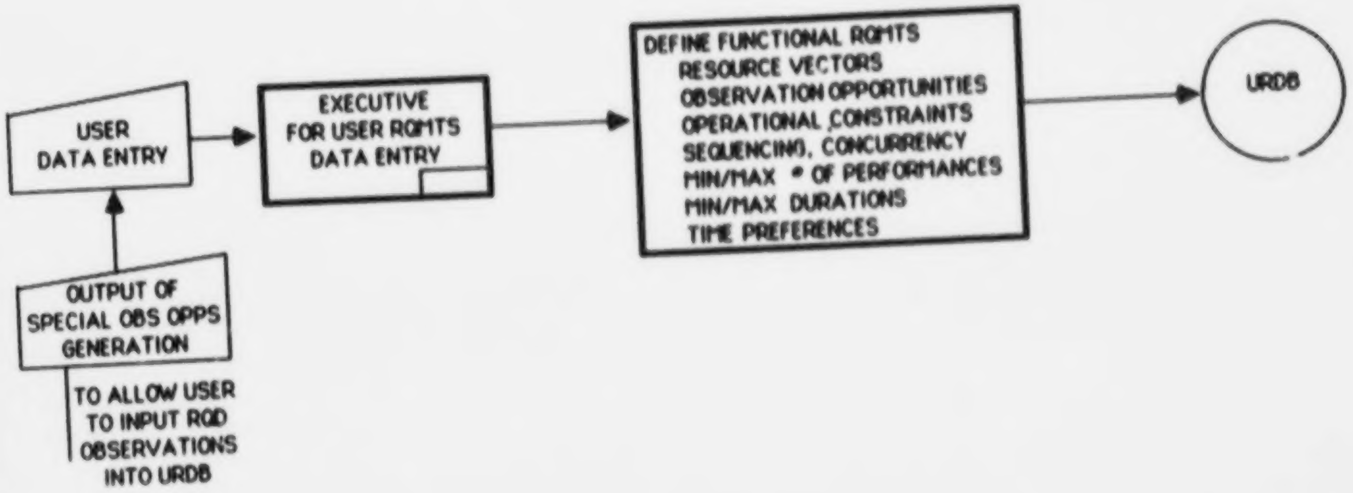
SUBFUNCTION: 3-SPECIAL OBSERVATION OPPORTUNITIES GENERATION

TASK: 3.6-MERGE OBSERVATION OPPORTUNITIES

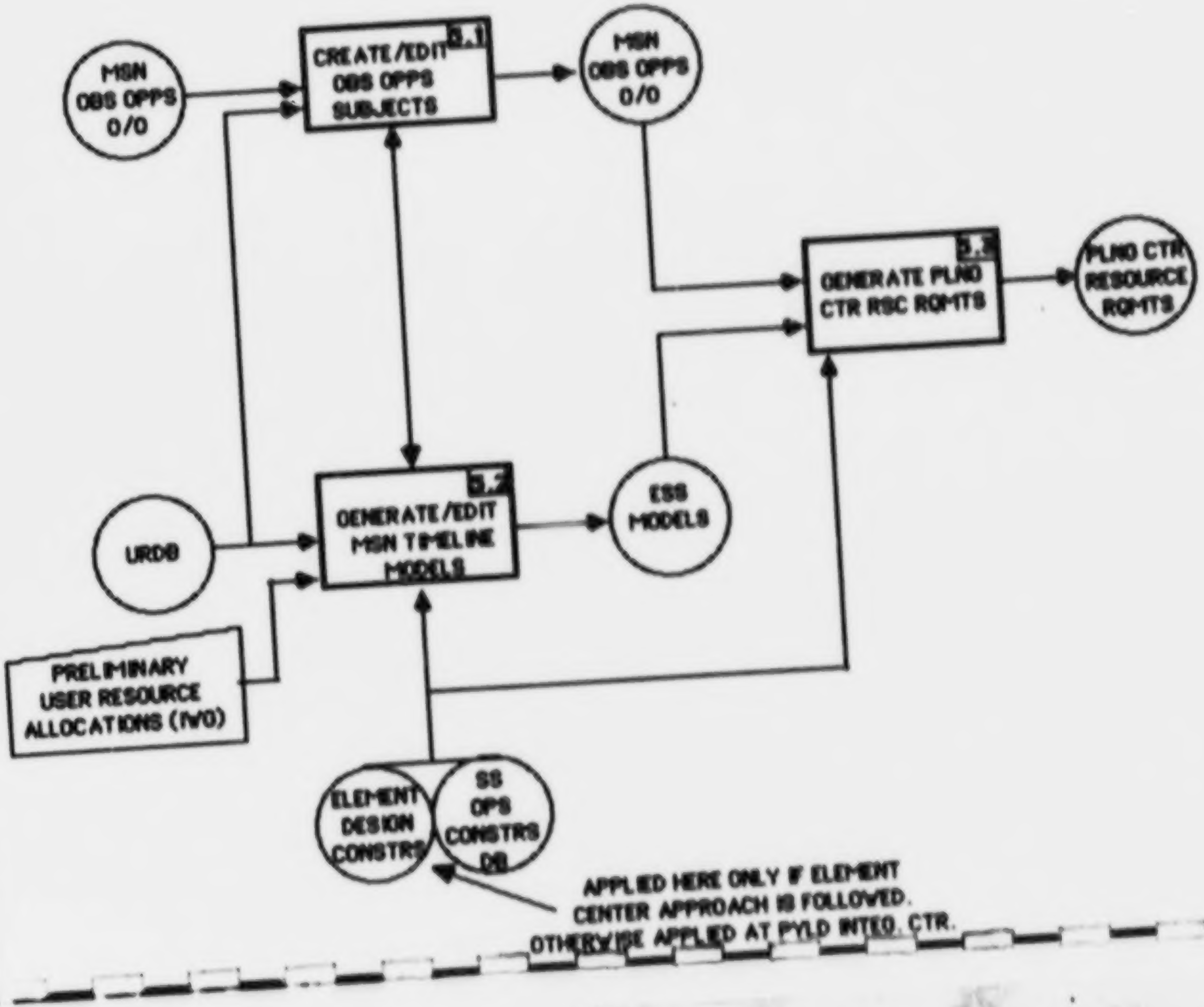

STND ORB OBS OPPS 0/0
EARTH OBS OPPS 0/0
ATMOS PHYSICS OBS OPPS 0/0
PLASMA PHYSICS OBS OPPS 0/0
SOLAR OBS OPPS 0/0
CEL OBS OPPS 0/0
MERGE OBS OPPS FILES
TARGEN
MSN OBS OPPS 0/0

SUBFUNCTION: 4-USER REQUIREMENTS DATA BASE I/F

NOTE: THIS SUBFUNCTION DEPICTS ONLY THOSE USER RQMTS NECESSARY FOR MISSION ON-ORBIT OPERATIONS PLANNING AND SCHEDULING. THE SS OPERATIONS CONCEPT MAY IMPOSE RQMTS FOR A CENTRALIZED DATA BASE INCORPORATING ALL USER INTEGRATION RQMTS. THIS CONCEPT ASSUMES THAT THE URDB I/F SW LEADS THE USER IN BUILDING MSN TL MODELS USEABLE BY THE EXPERIMENT SCHEDULING PROGRAM. THE FIDELITY OF THESE MODELS WILL BE AT THE EXPERIMENT LEVEL UNTIL THE EXECUTION PLNG PHASE AT WHICH TIME THEY WILL BE REFINED TO THE STEP LEVEL.

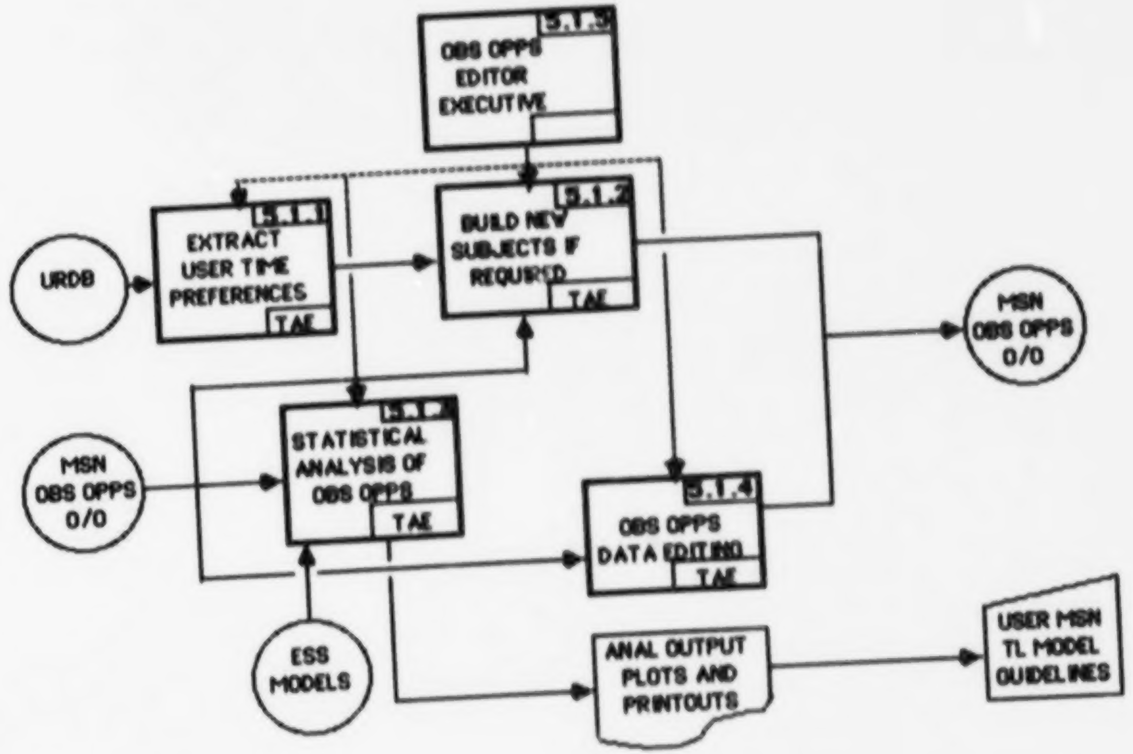

USER DATA ENTRY
EXECUTIVE FOR USER RQMTS DATA ENTRY
DEFINE FUNCTIONAL RQMTS
RESOURCE VECTORS
OBSERVATION OPPORTUNITIES
OPERATIONAL CONSTRAINTS
SEQUENCING, CONCURRENCY
MIN/MAX # OF PERFORMANCES
MIN/MAX DURATIONS
TIME PREFERENCES
URDB
OUTPUT OF SPECIAL OBS OPPS GENERATION
TO ALLOW USER TO INPUT RQD OBSERVATIONS INTO URDB

SUBFUNCTION: 5-GENERATE PLANNING CENTER INTEGRATED REQUIREMENTS


MSN OBS OPPS O/O
CREATE/EDIT OBS OPPS SUBJECTS
5.1
MSN OBS OPPS O/O
GENERATE PLNG CTR RSC RQMTS
5.3
PLNG CTR RESOURCE RQMTS
URDB
GENERATE/EDIT MSN TIMELINE MODELS
5.2
ESS MODELS
PRELIMINARY USER RESOURCE ALLOCATIONS (IVO)
ELEMENT DESIGN CONSTRS
SS OPS CONSTRS DB
APPLIED HERE ONLY IF ELEMENT CENTER APPROACH IS FOLLOWED. OTHERWISE APPLIED AT PYLD INTEG. CTR.

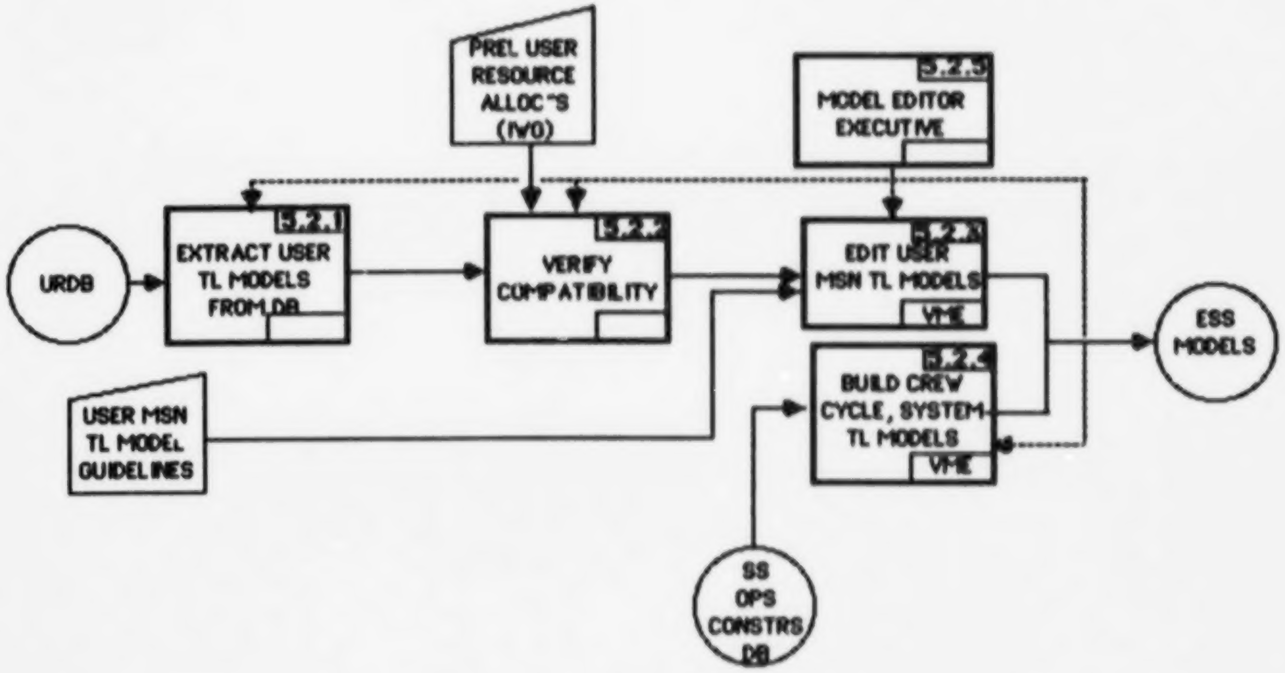
SUBFUNCTION: 5-GENERATE PLANNING CENTER INTEGRATED REQUIREMENTS

TASK: 5.1-CREATE/EDIT OBS OPPS SUBJECTS


5.1.5
OBS OPPS EDITOR EXECUTIVE
URDB
5.1.1
EXTRACT USER TIME PREFERENCES
TAE
5.1.2
BUILD NEW SUBJECTS IF REQUIRED
TAE
MSN OBS OPPS 0/0
5.1.3
STATISTICAL ANALYSIS OF OBS OPPS
TAE
5.1.4
OBS OPPS DATA EDITING
TAE
MSN OBS OPPS 0/0
ESS MODELS
ANAL OUTPUT PLOTS AND PRINTOUTS
USER MSN TL MODEL GUIDELINES

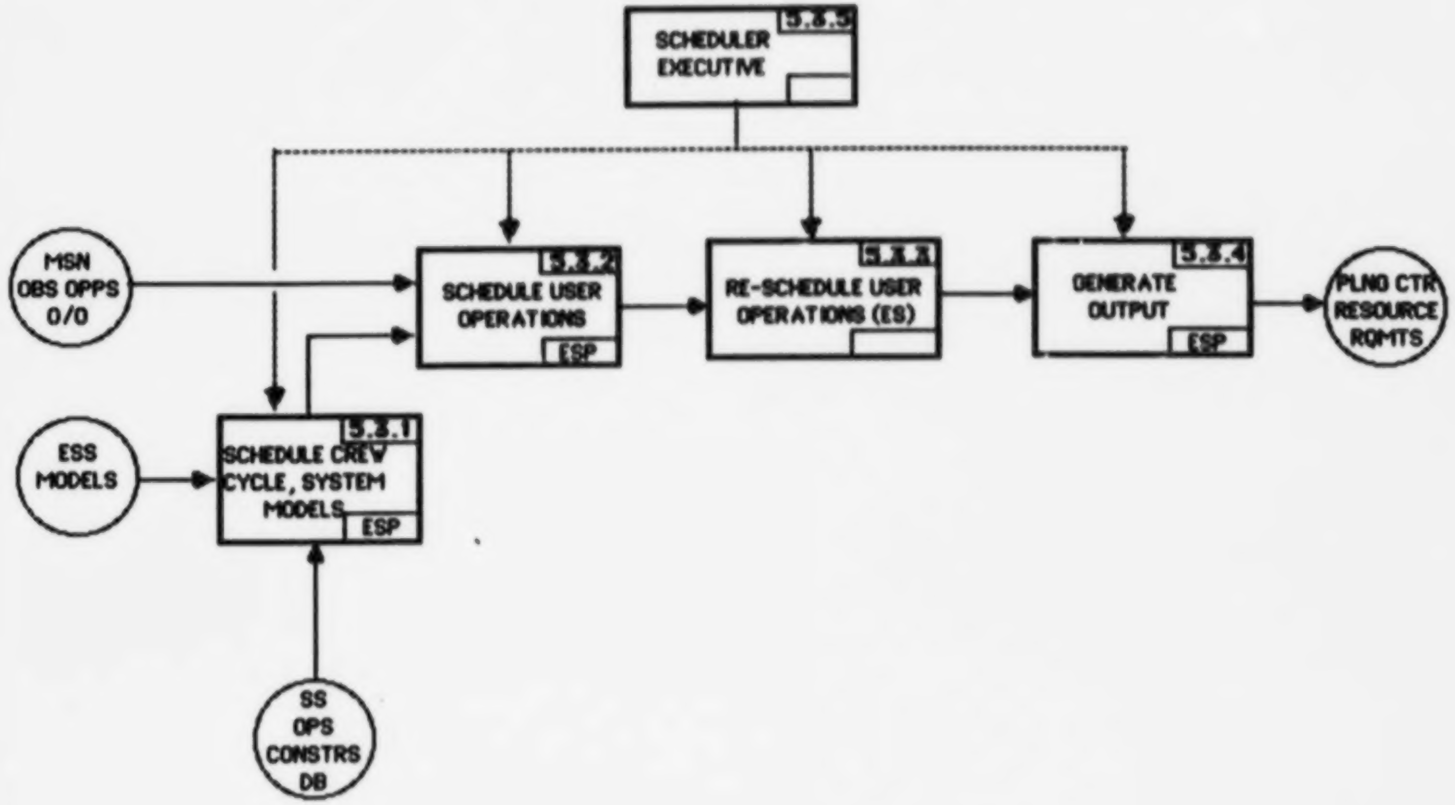
SUBFUNCTION: 5-GENERATE PLANNING CENTER INTEGRATED REQUIREMENTS

TASK: 5.2-GENERATE/EDIT MISSION TIMELINE MODELS

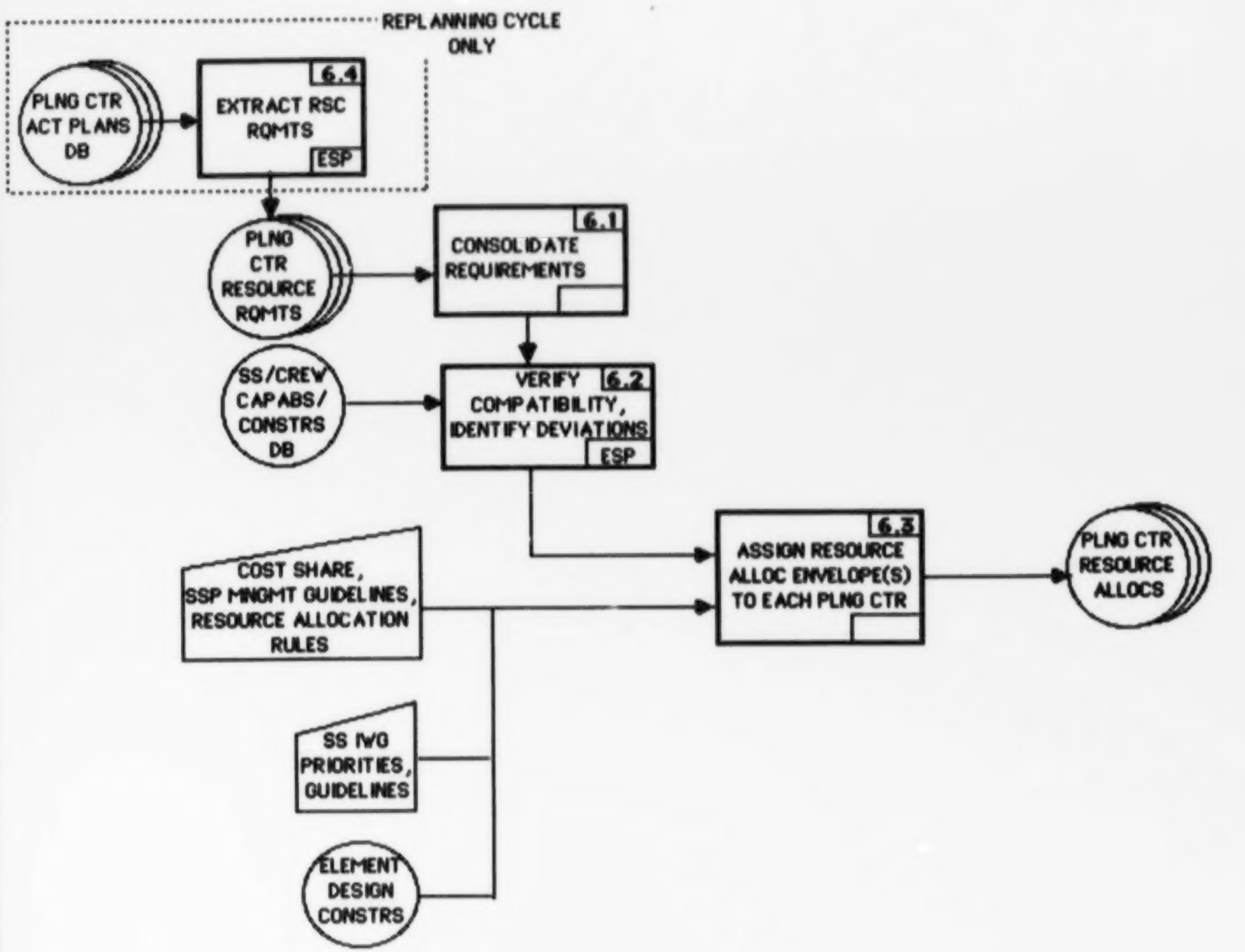

PREL USER RESOURCE ALLOC'S (IVO)
5.2.5
MODEL EDITOR EXECUTIVE
URDB
5.2.1
EXTRACT USER TL MODELS FROM DB
5.2.2
VERIFY COMPATIBILITY
5.2.3
EDIT USER MSN TL MODELS
VME
5.2.4
BUILD CREW CYCLE, SYSTEM TL MODELS
VME
ESS MODELS
USER MSN TL MODEL GUIDELINES
SS OPS CONSTRS DB

SUBFUNCTION: 5-GENERATE PLANNING CENTER INTEGRATED REQUIREMENTS

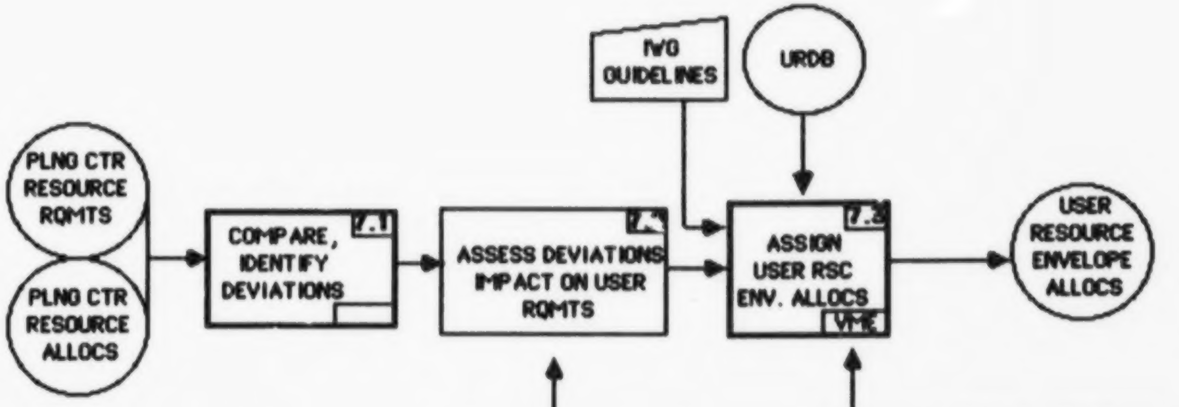
TASK: 5.3-GENERATE PLANNING CENTER RESOURCE REQUIREMENTS


5.3.5
SCHEDULER EXECUTIVE
MSN OBS OPPS 0/0
5.3.2
SCHEDULE USER OPERATIONS
ESP
5.3.3
RE-SCHEDULE USER OPERATIONS (ES)
5.3.4
GENERATE OUTPUT
ESP
PLNG CTR RESOURCE RQMTS
ESS MODELS
5.3.1
SCHEDULE CREW CYCLE, SYSTEM MODELS
ESP
SS OPS CONSTRS DB

SUBFUNCTION: 6-INTEGRATED ASSESSMENT OF PLANNING CENTER SUMMARY RQMTS


REPLANNING CYCLE ONLY
PLNG CTR ACT PLANS DB
6.4
EXTRACT RSC RQMTS
ESP
PLNG CTR RESOURCE RQMTS
6.1
CONSOLIDATE REQUIREMENTS
SS/CREW CAPABS/ CONSTRS DB
VERIFY COMPATIBILITY, IDENTIFY DEVIATIONS
6.2
ESP
COST SHARE, SSP MNGMT GUIDELINES, RESOURCE ALLOCATION RULES
SS IWG PRIORITIES, GUIDELINES
ELEMENT DESIGN CONSTRS
6.3
ASSIGN RESOURCE ALLOC ENVELOPE(S) TO EACH PLNG CTR
PLNG CTR RESOURCE ALLOCS

SUBFUNCTION: 7-ASSIGN USER RESOURCE ALLOCATION ENVELOPES


PLNG CTR RESOURCE RQMTS
PLNG CTR RESOURCE ALLOCS
7.1
COMPARE, IDENTIFY DEVIATIONS
7.2
ASSESS DEVIATIONS IMPACT ON USER RQMTS
IVO GUIDELINES
URDB
7.3
ASSIGN USER RSC ENV. ALLOCS
VME
USER RESOURCE ENVELOPE ALLOCS

MAY REQUIRE REPEATING TASK 5.3 IF PLNG CTR RESOURCE ALLOCS DO NOT SATISFY RESOURCE REQUIREMENTS

BASICALLY A FORMAL APPROVAL PROCESS OF THE USER RQMTS ENTERED IN THE URDB.

6.2.3.8 Subfunction 8 - Generate Planning Center Gross Timeline

This activity is basically a scheduling function which develops blocks of times within which each experiment may plan operations. This time block allocation approach allows the user flexibility in scheduling his individual operations while minimizing the number of iterations required to obtain a workable timeline. The tolerances included when allocating these time blocks will be a significant factor, essentially trading off user flexibility for schedule efficiency. The subfunction includes editing obs opps subjects; generating/editing mission timeline models; and generating the gross timeline with the appropriate output products to be included in the Tactical Operations Plan (TOP) Data Base.

6.2.3.9 Subfunction 9 - Integrated Assessment of Planning Center TOP's

This subfunction includes the following interrelated tasks: verify that each planning center TOP does not violate the planning center resource allocations; consolidate the planning center TOP's; identify any operational conflicts between users of separate planning centers or between SS systems and users; schedule centralized resources that are not completely handled by resource allocation (crew, data flow etc.); determine what changes are required to eliminate conflicts and satisfy user resource demands; and generate the Integrated Payload TOP.

6.2 3.10 Subfunction 10 - Generate User Activity Plans

This is a detailed activity where each user defines desired experiment operating times within the TOP-allocated time blocks and assigns specific start/stop times to each operating step (mode).

6.2.3.11 Subfunction 11 - Integrate User Activity Plans

This subfunction includes the integration of the activity plans of all users of a particular planning center; verifies compatibility with TOP allocations; consolidates users activity plans; verifies compatibility with other planning center users; re-schedules user operations to eliminate identified resource or operational conflicts; generates the planning center activity plan data base; and, in the daily planning cycle, generates the planning center detailed Payload Crew Activity Plan (PCAP).

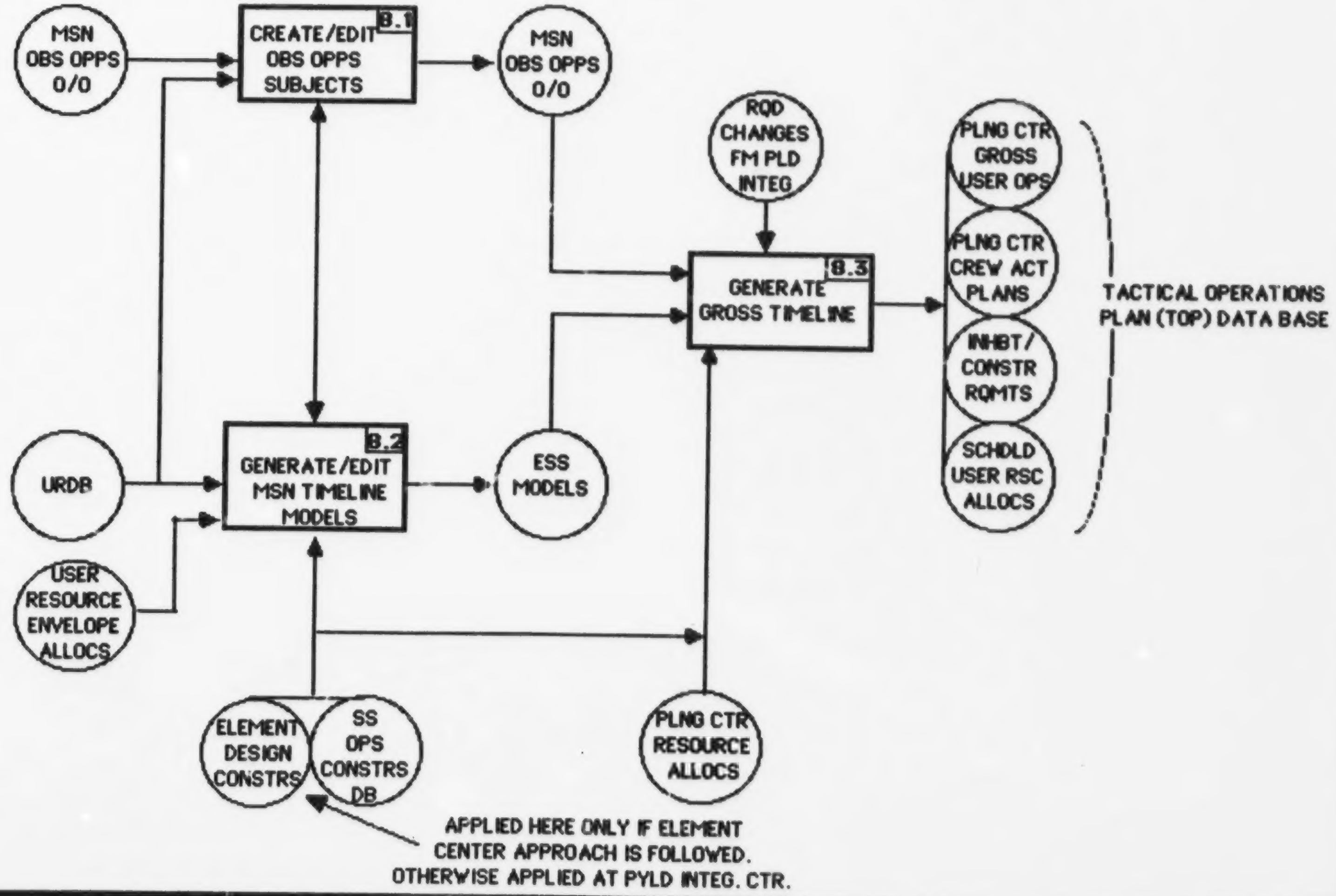
6.2.3.12 Subfunction 12 - Integrated Assessment of Planning Center Activity Plans

This activity is nearly identical to subfunction 11. The difference is that the integration is now at the overall SS payloads level (POIC) instead of the planning center level. The inputs are planning centers' activity plans and the outputs are the payload activity plans data base and payload summary PCAP.

6.2.3.13 Subfunction 13 - Generate User Command Plan

This subfunction includes the user activities of generating a command sequence to transition between steps (modes) of experiment operations and generating time windows during which these commands must occur based on the finalized user activity plans.

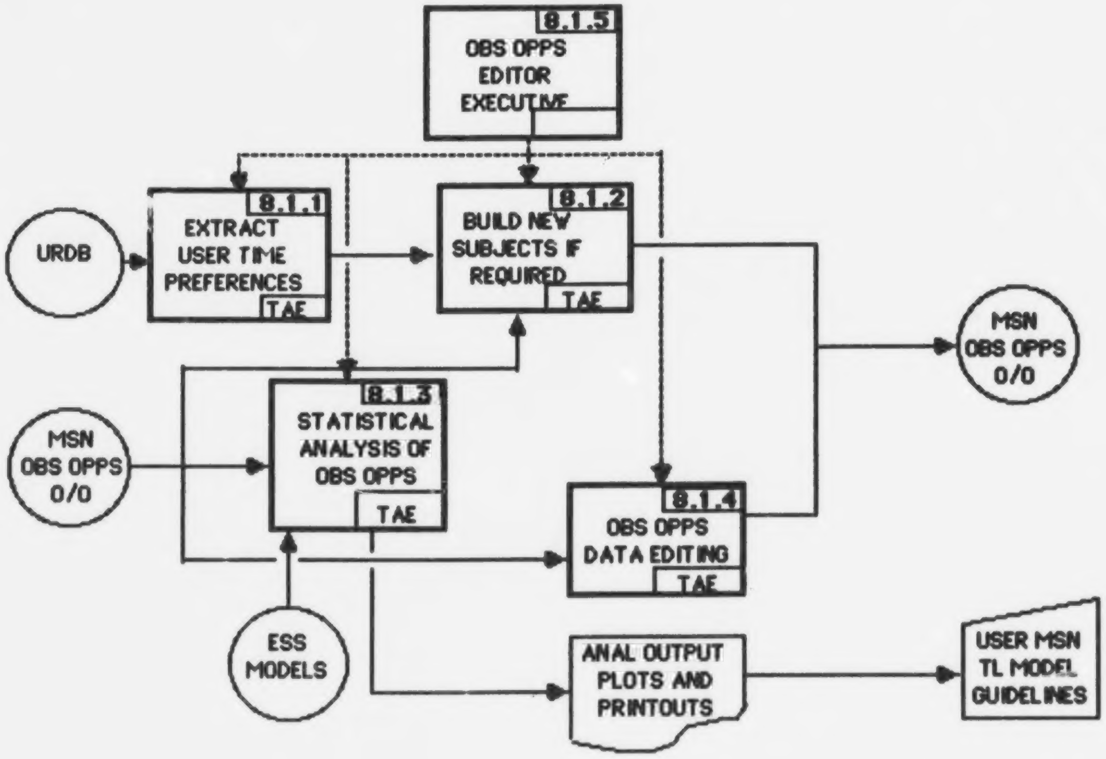
SUBFUNCTION: 8-GENERATE PLANNING CENTER GROSS TIMELINE


MSN
OBS OPPS
0/0
CREATE/EDIT
OBS OPPS
SUBJECTS
8.1
MSN
OBS OPPS
0/0
RQD
CHANGES
FM PLD
INTEG
GENERATE
GROSS TIMELINE
8.3
PLNG CTR
GROSS
USER OPS
PLNG CTR
CREW ACT
PLANS
INHBT/
CONSTR
RQMTS
SCHDLD
USER RSC
ALLOCS
TACTICAL OPERATIONS
PLAN (TOP) DATA BASE
URDB
GENERATE/EDIT
MSN TIMELINE
MODELS
8.2
ESS
MODELS
USER
RESOURCE
ENVELOPE
ALLOCS
ELEMENT
DESIGN
CONSTRS
SS
OPS
CONSTRS
DB
PLNG CTR
RESOURCE
ALLOCS
APPLIED HERE ONLY IF ELEMENT
CENTER APPROACH IS FOLLOWED.
OTHERWISE APPLIED AT PYLD INTEG. CTR.

SUBFUNCTION: 8-GENERATE PLANNING CENTER GROSS TIMELINE

TASK: 8.1-CREATE/EDIT OBS OPPS SUBJECTS

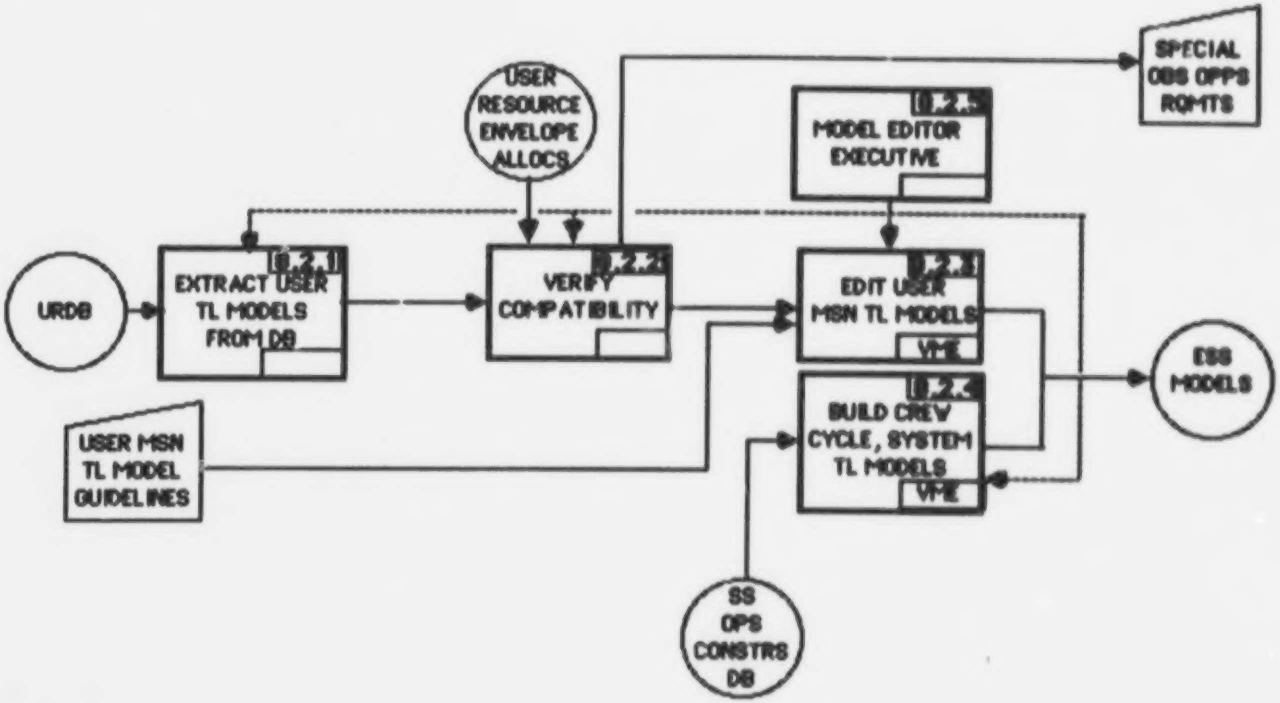
NOTE: SUBTASKS ARE SIMILIAR TO TASK 5.2, AND
ARE REPEATED HERE FOR CLARITY AND TO
IDENTIFY THE UNIQUE INPUTS AND OUTPUTS.


8.1.5
OBS OPPS EDITOR EXECUTIVE
URDB
8.1.1
EXTRACT USER TIME PREFERENCES
TAE
8.1.2
BUILD NEW SUBJECTS IF REQUIRED
TAE
MSN OBS OPPS O/O
8.1.3
STATISTICAL ANALYSIS OF OBS OPPS
TAE
MSN OBS OPPS O/O
8.1.4
OBS OPPS DATA EDITING
TAE
ESS MODELS
ANAL OUTPUT PLOTS AND PRINTOUTS
USER MSN TL MODEL GUIDELINES

SUBFUNCTION: 8-GENERATE PLANNING CENTER GROSS TIMELINE

TASK: 8.2-GENERATE/EDIT MISSION TIMELINE MODELS

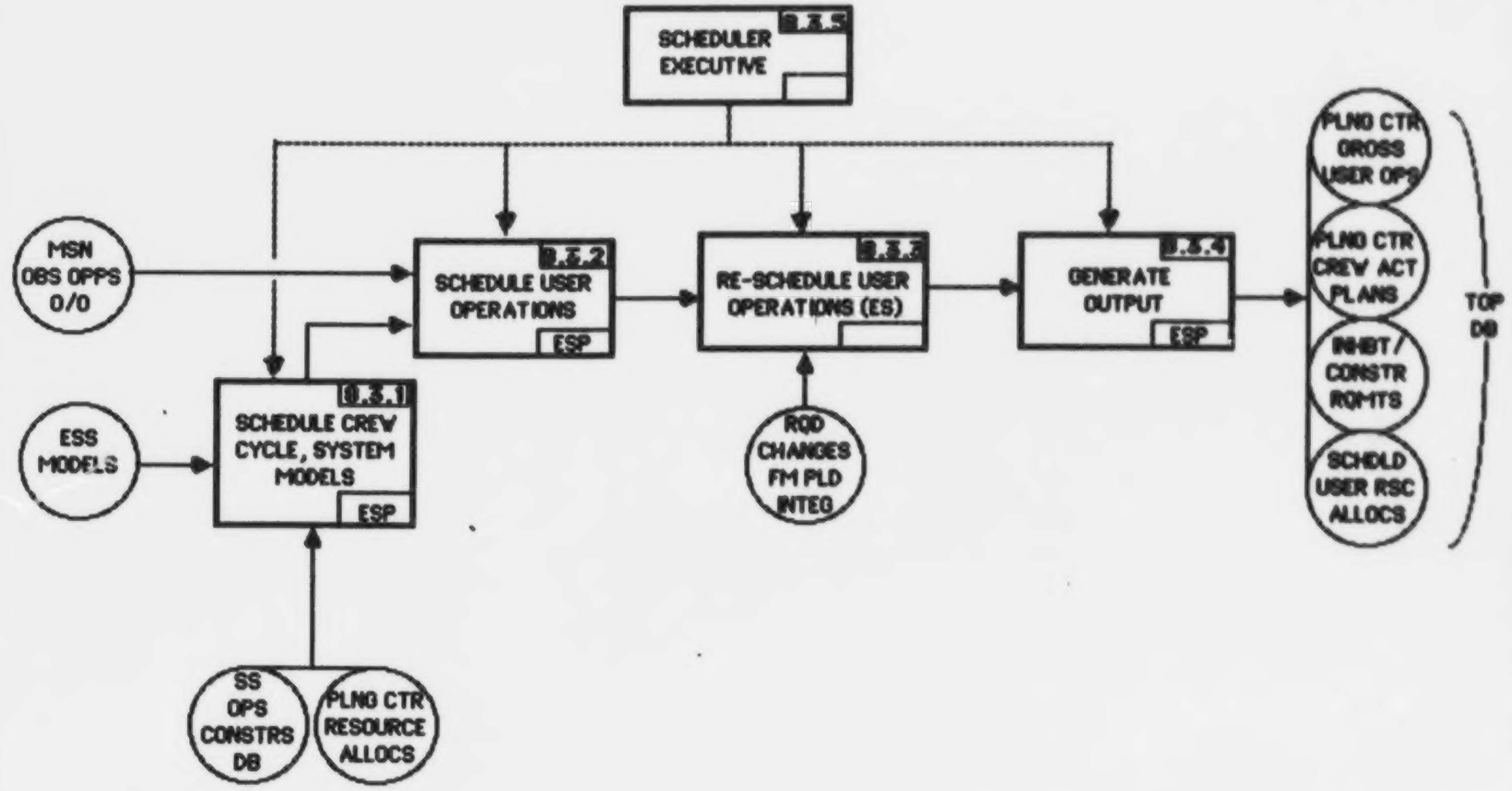
NOTE: SUBTASKS ARE SIMILIAR TO TASK 5.2, AND ARE REPEATED HERE FOR CLARITY AND TO IDENTIFY THE UNIQUE INPUTS AND OUTPUTS.


URDB
8.2.1
EXTRACT USER TL MODELS FROM DB
USER RESOURCE ENVELOPE ALLOCS
8.2.2
VERIFY COMPATIBILITY
USER MSN TL MODEL GUIDELINES
8.2.5
MODEL EDITOR EXECUTIVE
8.2.3
EDIT USER MSN TL MODELS
VME
8.2.4
BUILD CREW CYCLE, SYSTEM TL MODELS
VME
SS OPS CONSTRS DB
SPECIAL OBS OPPS RQMTS
DSS MODELS

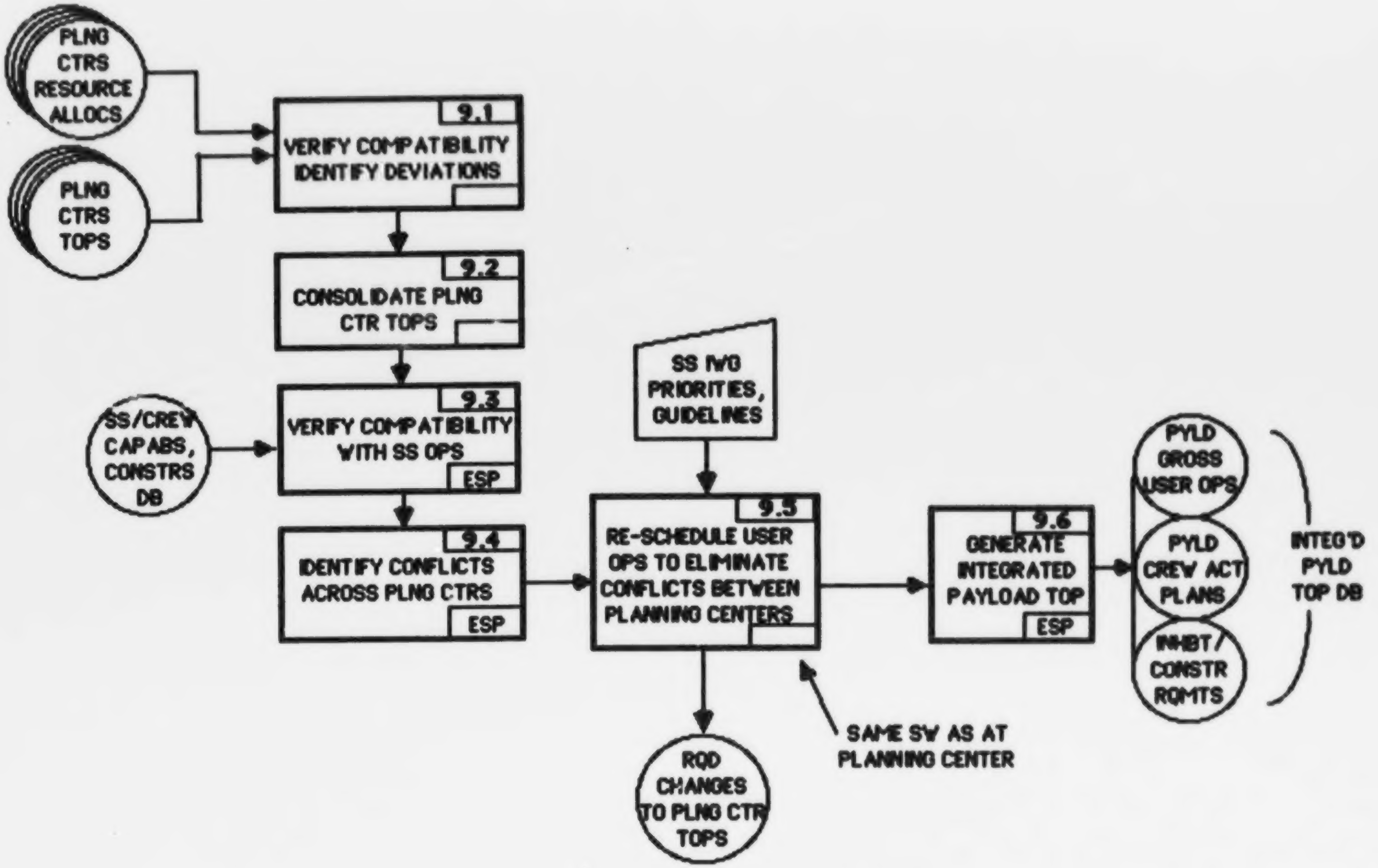
SUBFUNCTION: 8-GENERATE PLANNING CENTER GROSS TIMELINE

TASK: 8.3-GENERATE GROSS TIMELINE

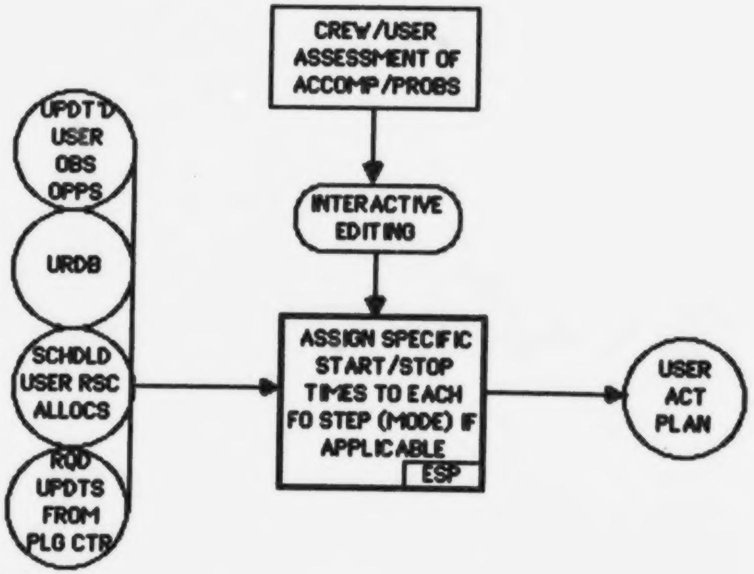
NOTE: SUBTASKS ARE SIMILIAR TO TASK 5.3, AND ARE REPEATED HERE FOR CLARITY AND TO IDENTIFY THE UNIQUE INPUTS AND OUTPUTS.


8.3.5
SCHEDULER EXECUTIVE
MSN OBS OPPS 0/0
8.3.2
SCHEDULE USER OPERATIONS
ESP
8.3.3
RE-SCHEDULE USER OPERATIONS (ES)
8.3.4
GENERATE OUTPUT
ESP
PLNG CTR GROSS USER OPS
PLNG CTR CREW ACT PLANS
INHBT/ CONSTR RQMTS
SCHDLD USER RSC ALLOCS
TOP DB
ESS MODELS
8.3.1
SCHEDULE CREW CYCLE, SYSTEM MODELS
ESP
RQD CHANGES FM PLD INTEG
SS OPS CONSTRS DB
PLNG CTR RESOURCE ALLOCS

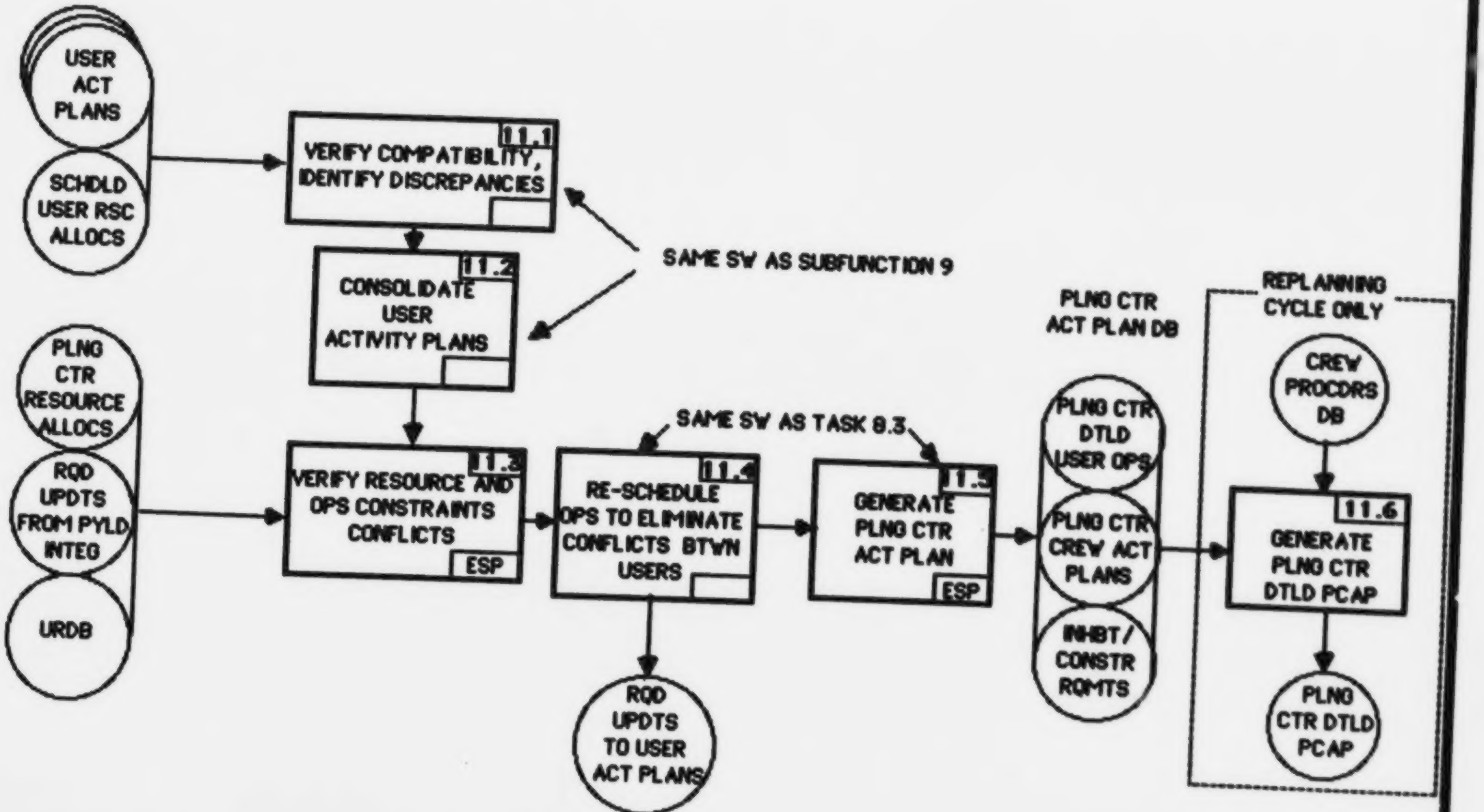
SUBFUNCTION: 9-INTEGRATED ASSESSMENT OF PLNG CTRS TOPS


PLNG CTRS RESOURCE ALLOCS
PLNG CTRS TOPS
9.1
VERIFY COMPATIBILITY IDENTIFY DEVIATIONS
9.2
CONSOLIDATE PLNG CTR TOPS
SS/CREW CAPABS, CONSTRS DB
9.3
VERIFY COMPATIBILITY WITH SS OPS
ESP
9.4
IDENTIFY CONFLICTS ACROSS PLNG CTRS
ESP
SS IWG PRIORITIES, GUIDELINES
9.5
RE-SCHEDULE USER OPS TO ELIMINATE CONFLICTS BETWEEN PLANNING CENTERS
RQD CHANGES TO PLNG CTR TOPS
SAME SW AS AT PLANNING CENTER
9.6
GENERATE INTEGRATED PAYLOAD TOP
ESP
PYLD GROSS USER OPS
PYLD CREW ACT PLANS
INHBT/CONSTR RQMTS
INTEG'D PYLD TOP DB

SUBFUNCTION: 10-GENERATE USER ACTIVITY PLANS

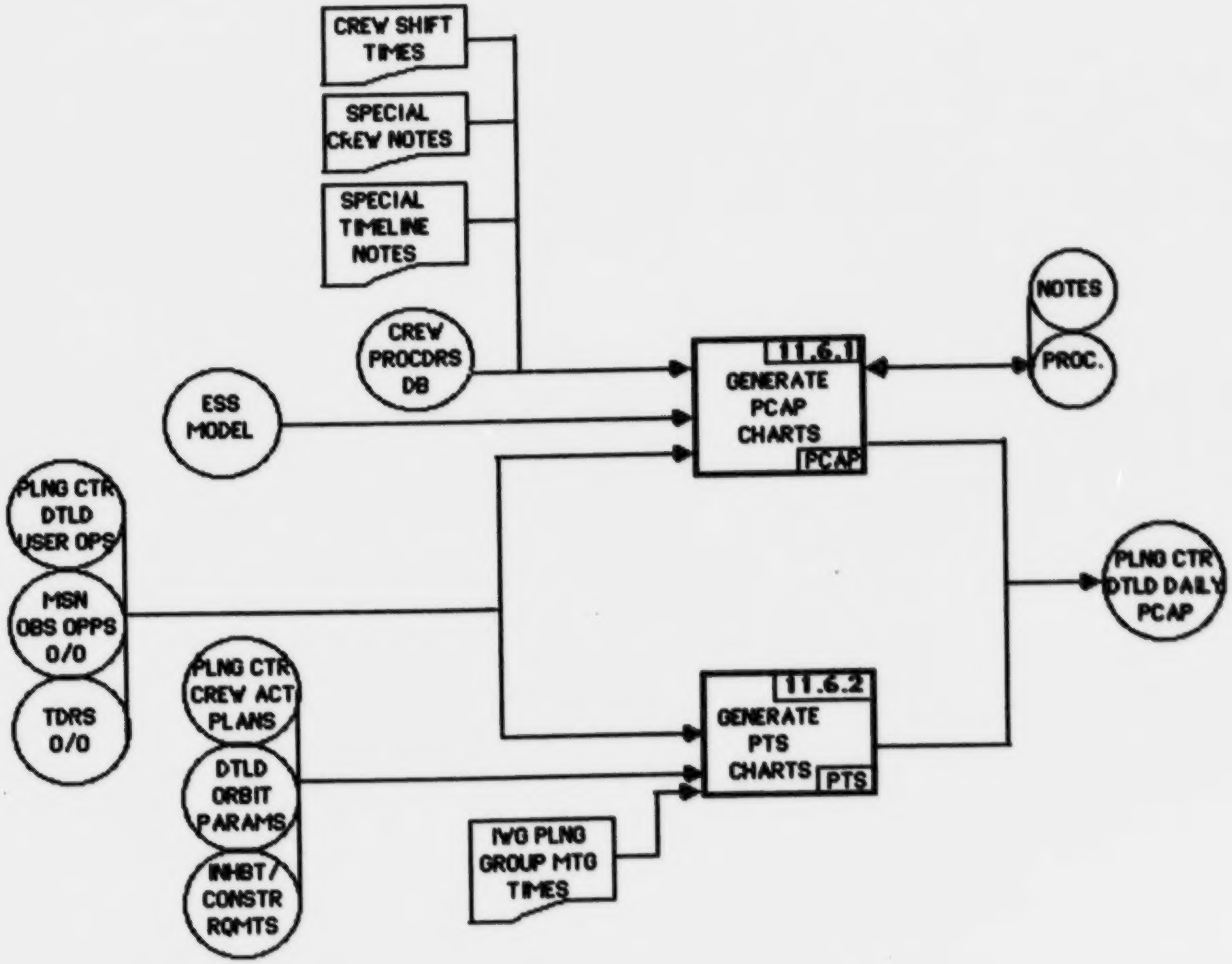

CREW/USER
ASSESSMENT OF
ACCOMP/PROBS
INTERACTIVE
EDITING
UPDT'D
USER
OBS
OPPS
URDB
SCHDLD
USER RSC
ALLOCS
RQD
UPDTS
FROM
PLG CTR
ASSIGN SPECIFIC
START/STOP
TIMES TO EACH
FO STEP (MODE) IF
APPLICABLE
ESP
USER
ACT
PLAN

SUBFUNCTION: 11-INTEGRATE USER ACTIVITY PLANS

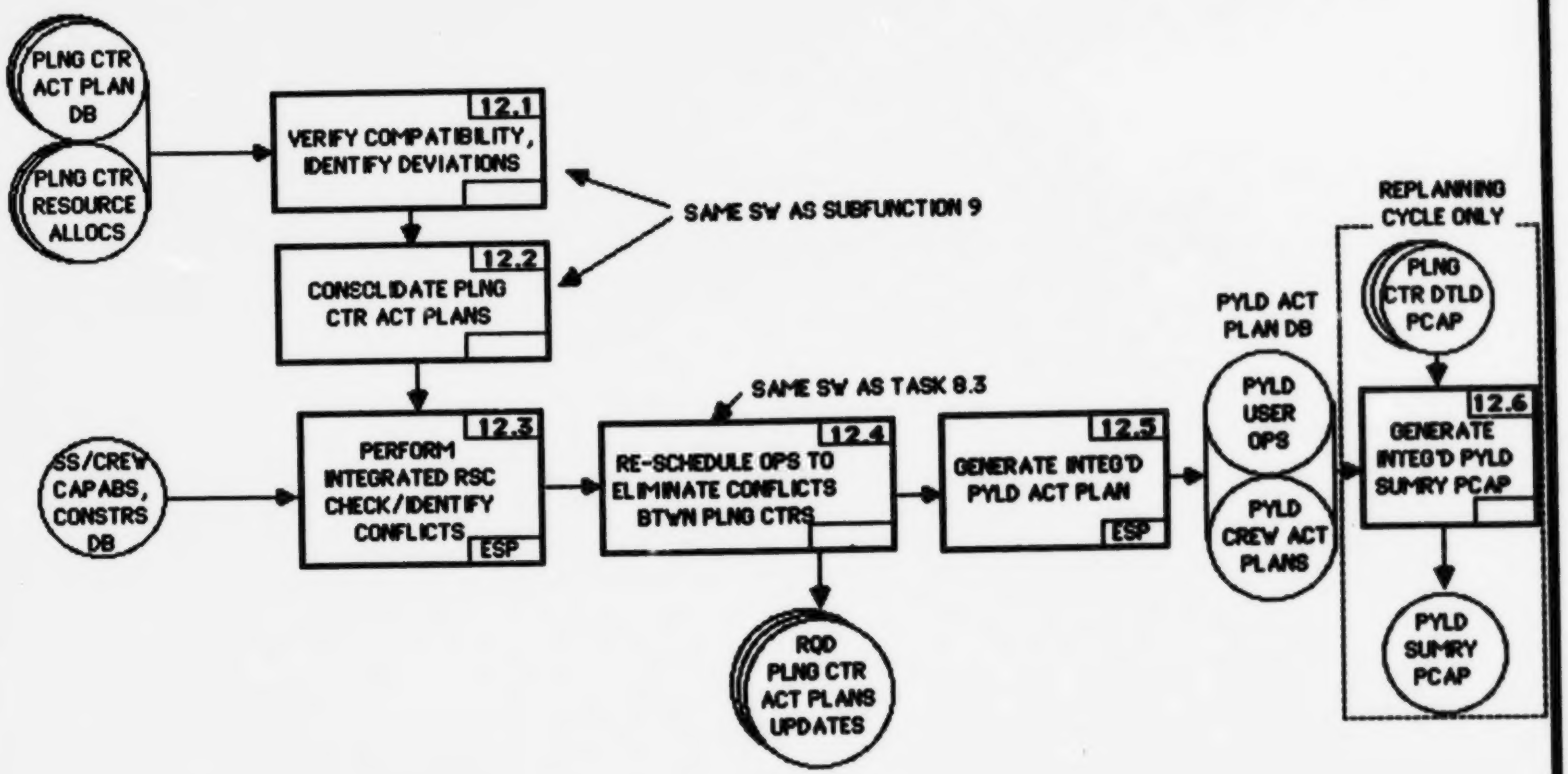

USER ACT PLANS
SCHDLD USER RSC ALLOCS
PLNG CTR RESOURCE ALLOCS
RQD UPDTS FROM PYLD INTEG
URDB
11.1
VERIFY COMPATIBILITY, IDENTIFY DISCREPANCIES
11.2
CONSOLIDATE USER ACTIVITY PLANS
SAME SW AS SUBFUNCTION 9
11.3
VERIFY RESOURCE AND OPS CONSTRAINTS CONFLICTS
ESP
SAME SW AS TASK 8.3
11.4
RE-SCHEDULE OPS TO ELIMINATE CONFLICTS BTWN USERS
RQD UPDTS TO USER ACT PLANS
11.5
GENERATE PLNG CTR ACT PLAN
ESP
PLNG CTR ACT PLAN DB
PLNG CTR DTLD USER OPS
PLNG CTR CREW ACT PLANS
INHBT/ CONSTR RQMTS
REPLANNING CYCLE ONLY
CREW PROCDRS DB
11.6
GENERATE PLNG CTR DTLD PCAP
PLNG CTR DTLD PCAP

SUBFUNCTION: 11-INTEGRATE USER ACTIVITY PLANS

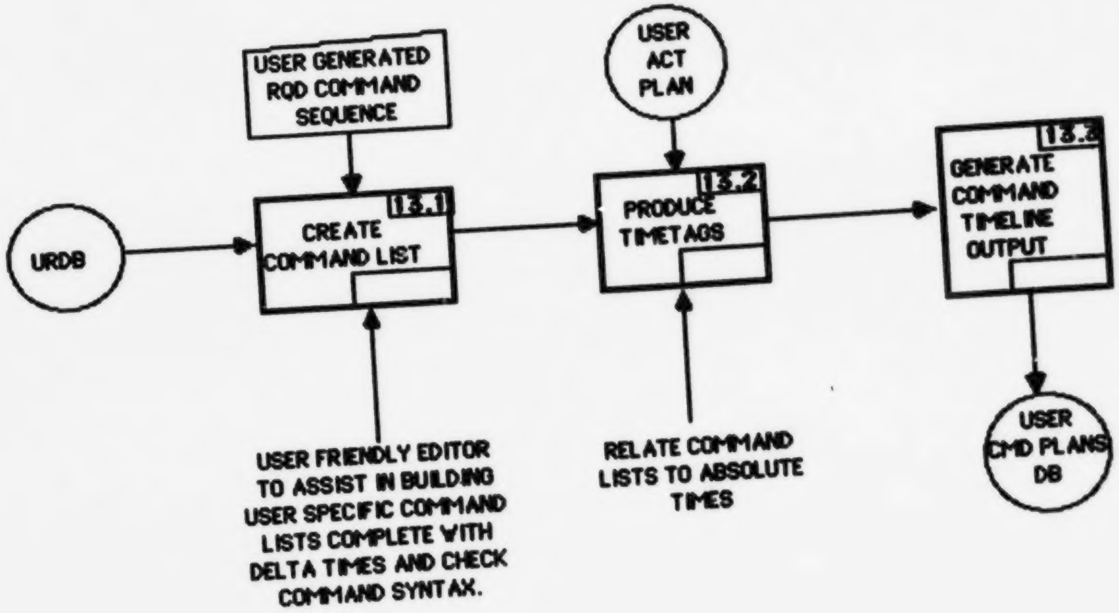
TASK: 11.6-GENERATE PLNG CTR DETAILED PCAP


CREW SHIFT TIMES
SPECIAL CREW NOTES
SPECIAL TIMELINE NOTES
CREW PROCDRS DB
ESS MODEL
PLNG CTR DTLD USER OPS
MSN OBS OPPS 0/0
TDRS 0/0
PLNG CTR CREW ACT PLANS
DTLD ORBIT PARAMS
INHBT/ CONSTR RQMTS
IWG PLNG GROUP MTG TIMES
11.6.1
GENERATE PCAP CHARTS
PCAP
11.6.2
GENERATE PTS CHARTS
PTS
NOTES
PROC.
PLNG CTR DTLD DAILY PCAP

SUBFUNCTION: 12-INTEGRATED ASSESSMENT OF PLNG CTR ACTIVITY PLANS


PLNG CTR ACT PLAN DB
PLNG CTR RESOURCE ALLOCS
12.1
VERIFY COMPATIBILITY, IDENTIFY DEVIATIONS
SAME SW AS SUBFUNCTION 9
12.2
CONSOLIDATE PLNG CTR ACT PLANS
SS/CREW CAPABS, CONSTRS DB
12.3
PERFORM INTEGRATED RSC CHECK/IDENTIFY CONFLICTS
ESP
SAME SW AS TASK 8.3
12.4
RE-SCHEDULE OPS TO ELIMINATE CONFLICTS BTWN PLNG CTRS
RQD PLNG CTR ACT PLANS UPDATES
12.5
GENERATE INTEG'D PYLD ACT PLAN
ESP
PYLD ACT PLAN DB
PYLD USER OPS
PYLD CREW ACT PLANS
REPLANNING CYCLE ONLY
PLNG CTR DTLD PCAP
12.6
GENERATE INTEG'D PYLD SUMRY PCAP
PYLD SUMRY PCAP

SUBFUNCTION: 13-GENERATE USER COMMAND PLANS


USER GENERATED RQD COMMAND SEQUENCE
USER ACT PLAN
URDB
13.1
CREATE COMMAND LIST
13.2
PRODUCE TIMETAGS
13.3
GENERATE COMMAND TIMELINE OUTPUT
USER CMD PLANS DB
USER FRIENDLY EDITOR TO ASSIST IN BUILDING USER SPECIFIC COMMAND LISTS COMPLETE WITH DELTA TIMES AND CHECK COMMAND SYNTAX.
RELATE COMMAND LISTS TO ABSOLUTE TIMES

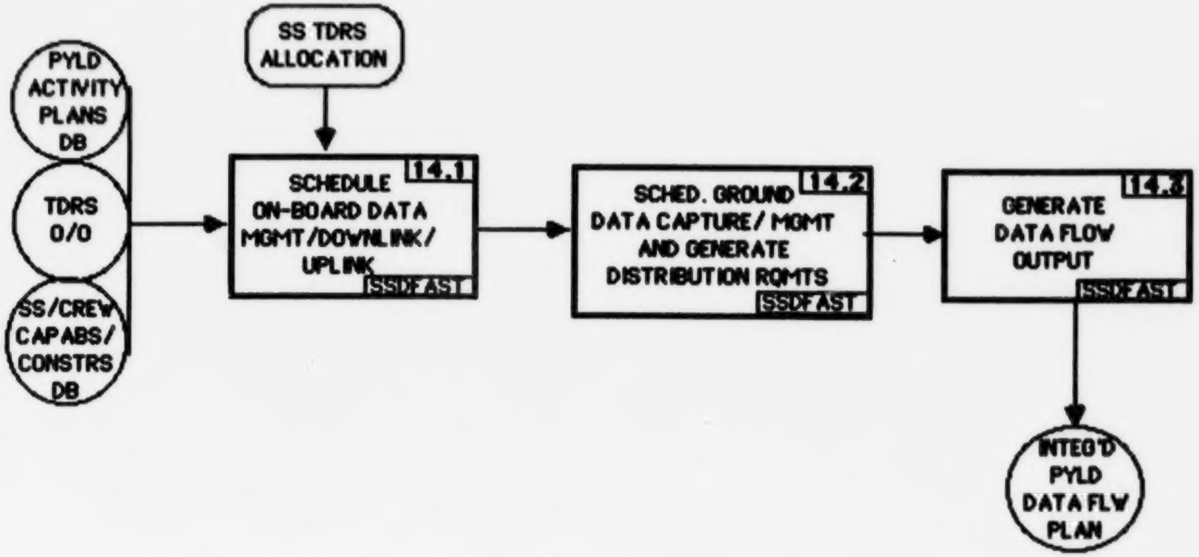
6.2.3.14 Subfunction 14 - Generate Integrated Payload Data Flow Plan

This activity involves scheduling overall payload data flow activities such as on-board data management of downlink/uplink and ground data capture, management and distribution as well as generating the integrated data flow plan.

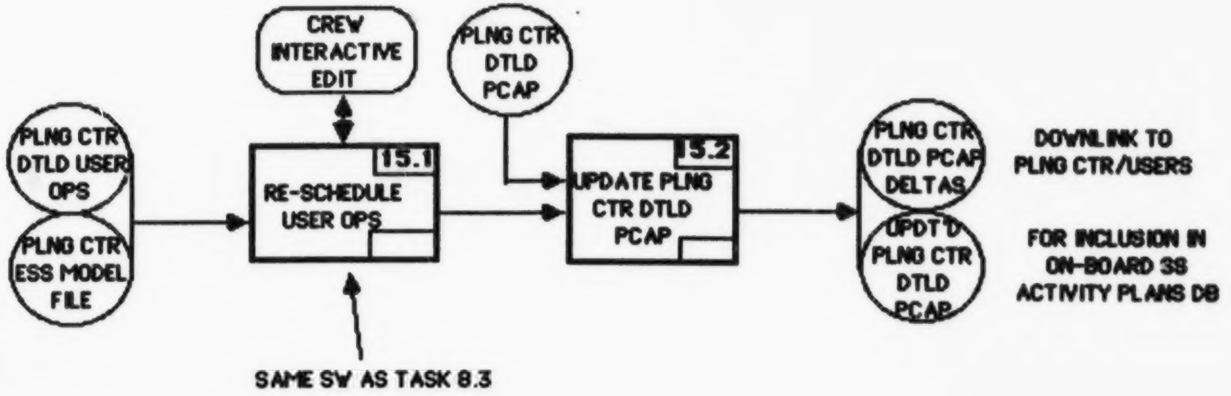
6.2.3.15 Subfunction 15 - Onboard Rescheduling

This subfunction allows for minor re-scheduling on-board by the SS crew. Accompanying activities of updating the PCAP and coordinating the changes with the ground are also required. Whether or not the overall SS operations concepts allow for on-orbit re-scheduling is as yet unresolved. The magnitude of the data requirements and the use of on-orbit crew time may force elimination of this subfunction.

SUBFUNCTION: 14-GENERATE INTEGRATED PAYLOAD DATA FLOW PLAN


SS TDRS ALLOCATION
PYLD ACTIVITY PLANS DB
TDRS 0/0
SS/CREW CAPABS/ CONSTRS DB
14.1
SCHEDULE ON-BOARD DATA MGMT/DOWNLINK/ UPLINK
SSDFAST
14.2
SCHED. GROUND DATA CAPTURE/ MGMT AND GENERATE DISTRIBUTION RQMTS
SSDFAST
14.3
GENERATE DATA FLOW OUTPUT
SSDFAST
INTEG'D PYLD DATA FLW PLAN

SUBFUNCTION: 15-ONBOARD RE-SCHEDULING


PLNG CTR DTLD USER OPS
PLNG CTR ESS MODEL FILE
CREW INTERACTIVE EDIT
15.1
RE-SCHEDULE USER OPS
PLNG CTR DTLD PCAP
15.2
UPDATE PLNG CTR DTLD PCAP
PLNG CTR DTLD PCAP DELTAS
UPDT'D PLNG CTR DTLD PCAP
DOWNLINK TO PLNG CTR/USERS
FOR INCLUSION IN ON-BOARD SS ACTIVITY PLANS DB
SAME SW AS TASK 8.3

6.3 SS MPS SOFTWARE REQUIREMENTS SUMMARY

Figure 6.3-1a presents a hierarchical structure of the software modules envisioned to be required to implement the SS payload mission planning concept presented in the previous subsection; this structure is oriented toward the SS planning organizations (users, planning centers, POIC) and includes the definition of executive programs to interface with the using organizations and to control the execution of lower level software modules. Figure 6.3-1a also identifies (per the figure legend) the modified SL MIPS, new, and AI-application candidate software programs. (Section 7 presents the rationale for the AI-application candidates.)

Figure 6.3-1b identifies additional software modules required to implement the SS payload mission planning concept. The modules identified are those envisioned to be required to be provided to the on-board crew and the Space Station Systems organization for mission planning and will have to be integrated into the software systems to be developed for the crew and systems organization.

For the purposes of assessing the applicability of AI techniques to the SS MPS in Task 4 of the study, and for generating the Software Development Plan in Task 5, the computer programs identified in Figure 6.3-1 were grouped into software sets - i.e., groups of programs of a similiar nature at the same hierarchical level. The software sets are presented in Table 6.3-1. Note that Sets E and F identify Phase I and II versions of the three "System Executives". The distinctions between these versions are explained in the Table 6.3-3 introduced in the following paragraph.

Finally, pages 6-52 through 6-65 of this section present a table (Table 6.3-2) which describes the individual software module requirements to implement the SS MPS concept. The table identifies each required software module by name and whether the module is new or a modified SL MIPS software module. Also provided is a functional description of each module. Finally, each software module is correlated to subfunctions/tasks in the SS mission planning concept functional flow diagrams presented previously.

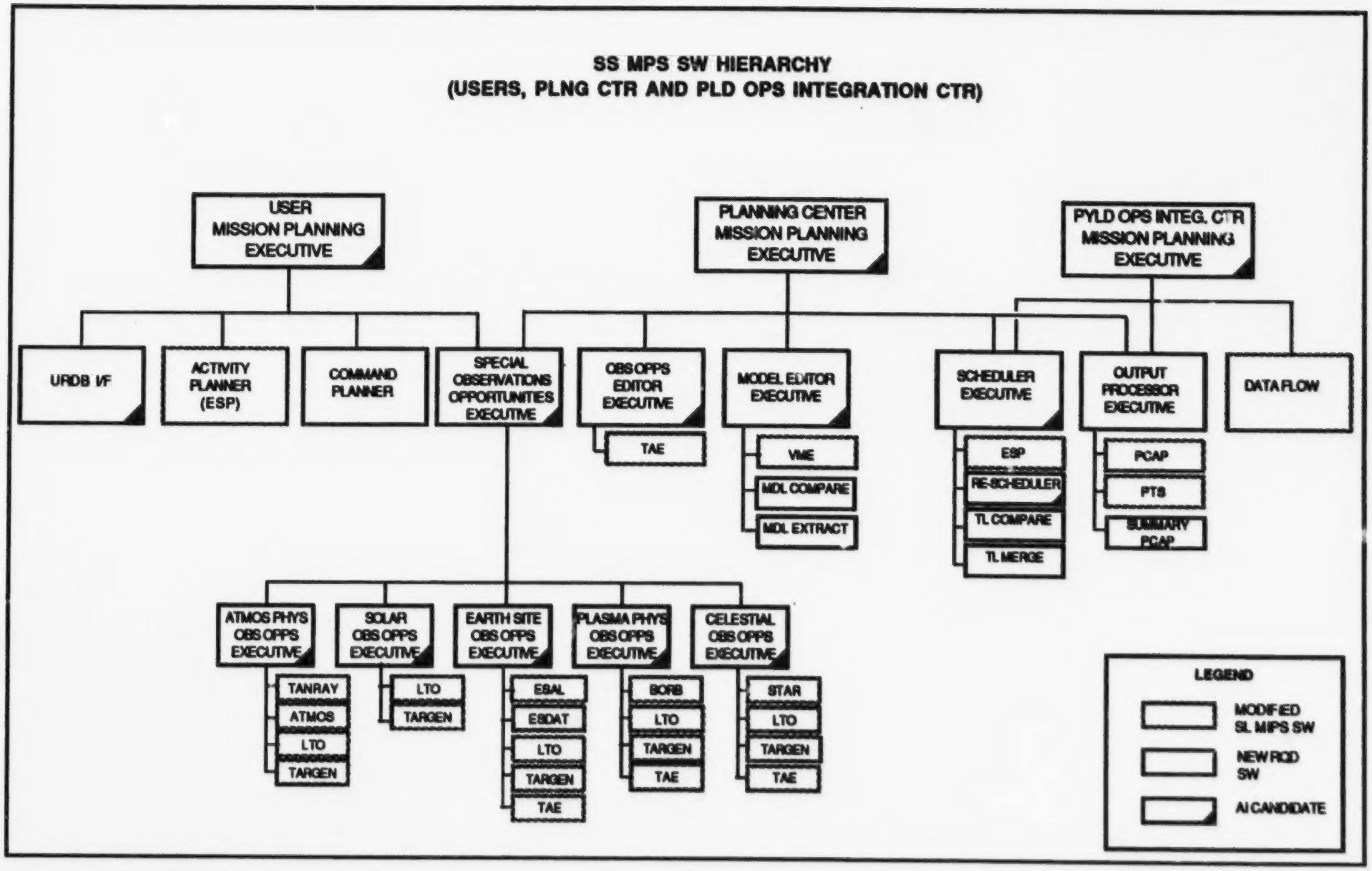

SS MPS SW HIERARCHY
(USERS, PLNG CTR AND PLD OPS INTEGRATION CTR)
USER MISSION PLANNING EXECUTIVE
PLANNING CENTER MISSION PLANNING EXECUTIVE
PYLD OPS INTEG. CTR MISSION PLANNING EXECUTIVE
URDB I/F
ACTIVITY PLANNER (ESP)
COMMAND PLANNER
SPECIAL OBSERVATIONS OPPORTUNITES EXECUTIVE
OBS OPPS EDITOR EXECUTIVE
TAE
MODEL EDITOR EXECUTIVE
VME
MDL COMPARE
MDL EXTRACT
SCHEDULER EXECUTIVE
ESP
RE-SCHEDULER
TL COMPARE
TL MERGE
OUTPUT PROCESSOR EXECUTIVE
PCAP
PTS
SUMMARY PCAP
DATA FLOW
ATMOS PHYS OBS OPPS EXECUTIVE
TANRAY
ATMOS
LTO
TARGEN
SOLAR OBS OPPS EXECUTIVE
LTO
TARGEN
EARTH SITE OBS OPPS EXECUTIVE
ESAL
ESDAT
LTO
TARGEN
TAE
PLASMA PHYS OBS OPPS EXECUTIVE
BORB
LTO
TARGEN
TAE
CELESTIAL OBS OPPS EXECUTIVE
STAR
LTO
TARGEN
TAE
LEGEND
MODIFIED SL MPS SW
NEW RQD SW
AI CANDIDATE

FIGURE 6.3-1a. SS MPS SW Hierarchy

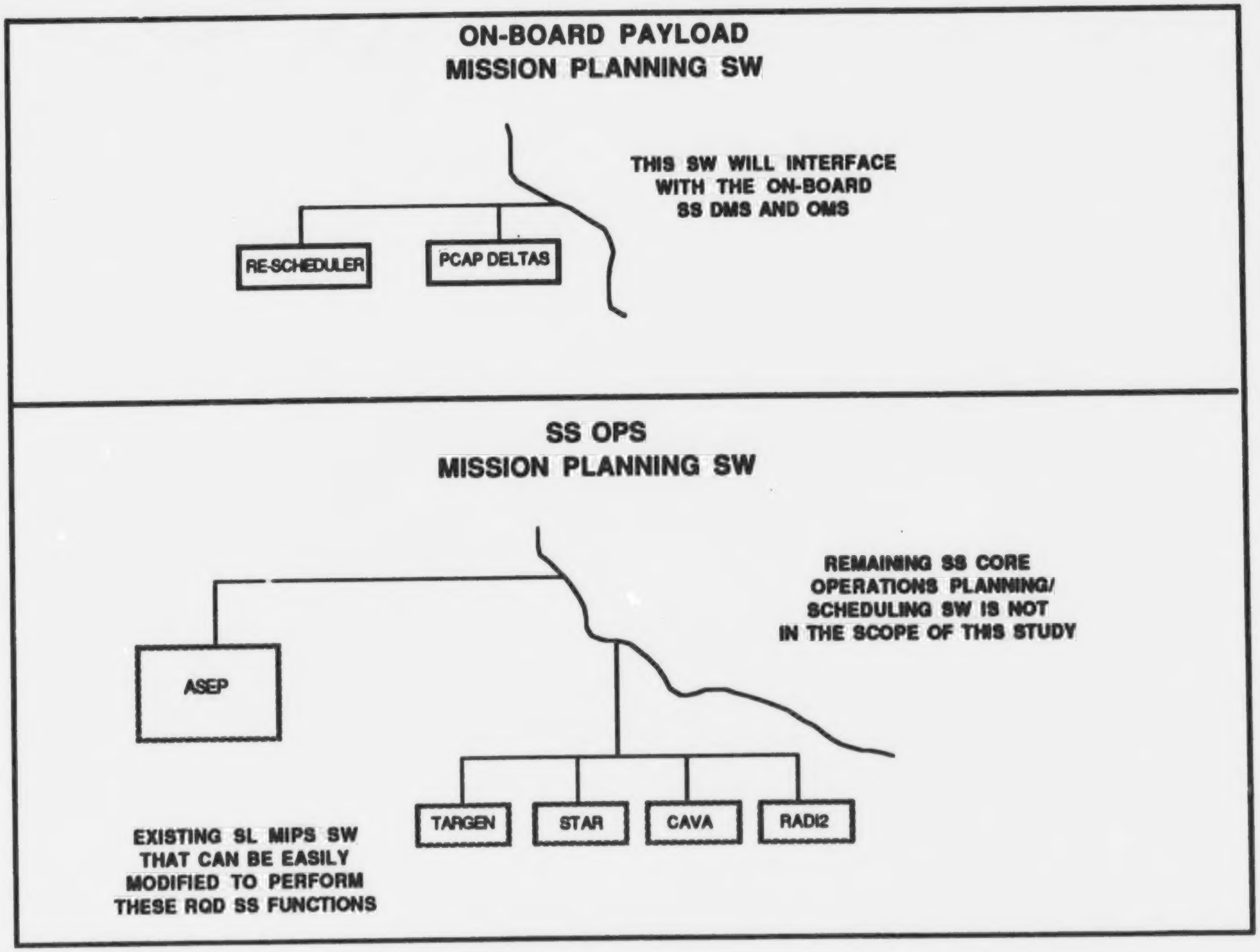

ON-BOARD PAYLOAD
MISSION PLANNING SW
RE-SCHEDULER
PCAP DELTAS
THIS SW WILL INTERFACE
WITH THE ON-BOARD
SS DMS AND OMS
SS OPS
MISSION PLANNING SW
ASEP
TARGEN
STAR
CAVA
RADI2
REMAINING SS CORE
OPERATIONS PLANNING/
SCHEDULING SW IS NOT
IN THE SCOPE OF THIS STUDY
EXISTING SL MIPS SW
THAT CAN BE EASILY
MODIFIED TO PERFORM
THESE RQD SS FUNCTIONS

FIGURE 6.3-1b. SS MPS SW HIERARCHY

TABLE 6.3-1. SS MPS SOFTWARE SETS

NEW SOFTWARE

- SET A - SPECIAL OBS OPPS EXECUTIVES
    - TOP LEVEL
    - ATMOS PHYS
    - SOLAR
    - EARTH SITE
    - PLASMA PHYSICS
    - CELESTIAL
- SET B - URDB I/F
- SET C - EDITOR EXECUTIVES
    - MODEL EDITOR EXEC
    - OBS OPPS EDITOR EXEC
    - SCHEDULER EXEC
- SET D - RE-SCHEDULER
- SET E - SYSTEM EXECUTIVES (PHASE I)
    - USER MPS EXEC
    - PLANNING CENTER MPS EXEC
    - POIC MPS EXEC
- SET F - SYSTEM EXECUTIVES (PHASE II)
    - USER MPS EXEC
    - PLANNING CENTER MPS EXEC
    - POIC MPS EXEC
- SET G - COMMAND PLANNER
- SET H - NEW TIMELINE ANALYSIS MODULES
    - MDL EXTRACT
    - MDL COMPARE
    - TL COMPARE
    - TL MERGE
    - PCAP DELTAS
    - SUMMARY PCAP
- SET L - OUTPUT PROCESSOR EXEC

MODIFIED SL MIPS SOFTWARE

- SET I - TIMELINE ANALYSIS
    - ESP
    - PCAP
    - PTS
    - TAE
    - VME
- SET J - ORBIT ANALYSIS
    - ASEP
    - ATMOS
    - BORB
    - CAVA
    - ESAL
    - ESDATA
    - LTO
    - RADI2
    - STAR
    - TANRAY
    - TARGEM
- SET K - DATA FLOW ANALYSIS
    - PROFILE
    - MISSION WINDOWS
    - ONBOARD RECORDER SCHEDULAR
    - POSSIBLE FORMATS
    - FORMAT SCHEDULAR
    - POSSIBLE POCC CONFIGURATIONS
    - POCC CONFIGURATION SCHEDULAR
    - PLAYBACK SCHEDULAR
    - INTERACTIVE DATA UPDATE SYSTEM
    - VERIFICATION
    - COMPARE TDRS
    - COMPARE MODELS
    - DATA MANAGEMENT CHECKLIST
    - DATA SCHEDULE FILE
    - ANTENNA DISPLAY
    - IDMS LIBRARY

Table 6.3-2

SS MPS SOFTWARE REQUIREMENTS SUMMARY

PAGE 1

SW MODULE NAME	NEW OR MODIFIED	SW MODULE FUNCTIONAL DESCRIPTION	APPLICABLE SUBFUNCTION/TASK
ASEP	MODIFIED	SEE SL MIPS DB. MODIFICATIONS CONSIST OF THE ADDITION OF A ROUTINE TO HANDLE DRAG ANALYTICALLY AND AN OPTION TO WRITE ASCN NODE, DTLD EPHEM AND GND TRCK DATA ON ONE LDF AND EARTH SHADOW ON AN O/O FILE. SHOULD BE SET UP TO PERIODICALLY ACCESS INPUT DATA AND PRODUCE OUTPUT FILES WITH MINIMUM MISSION PLANNERS INTERACTION. INPUT FILES: SOLAR ACTIVITY PROJECTIONS ACTUAL STATE VECTOR OUTPUT FILES: DTLD ORBIT PARAMS LDF EARTH SHADOW O/O	1 SS PROJECTED ORBIT EPHEMERIS GENERATION
TARGEN	MODIFIED	SEE SL MIPS DB. IN THE SS MISSION PLANNING SYSTEM TARGEN WILL BE CALLED AT VARIOUS TIMES TO APPLY CONSTRAINTS AND PERFORM RQD SET THEORY OPERATIONS. MODIFICATIONS RQD WILL CONSIST PRIMARILY OF INTERFACES WITH THE VARIOUS SPECIAL OBSERVATION OPPORTUNITIES EXECUTIVES. INPUT FILES: ANY LIST DIRECTED FILE ANY O/O FILE OUTPUT FILES: AN O/O FILE	2.1 GENERATE SUN RISE/SET 2.5 MERGE STANDARD ORBIT OBS OPPS 3.1.3 COMPUTE TERMINATOR TARGETS 3.1.4 COMBINE CONSTRS AND APPLY FILE MERGE OPPS 3.2.2 COMBINE CONSTRS TO DEFINE SOLAR OBS OPPS 3.3.4 APPLY CONSTRS TO EARTH SITE OBS OPPS 3.4.5 APPLY CONSTRAINTS AND MERGE OPPS 3.5.4 MERGE CELESTIAL OBS OPPS FILES 3.6 MERGE OBS OPPS FILES
STAR	MODIFIED	SEE SL MIPS DB-ADDITIONS/MODIFICATIONS WILL BE TO READ DTLD ORBIT PARAMS FILE INSTEAD OF AN ASCN NODE FILE. PROGRAM WILL ALSO GENERATE SEPARATE NIGHT AND NON-NIGHT CELESTIAL OBS DEFN AND OBS OPPS FILES. CAPABILITY MUST BE PROVIDED TO ENTER DEFNS AND CONSTRAINTS INTERACTIVELY THROUGH THE CELESTIAL OBS OPPS EXECUTIVE. INPUT FILES: DTLD ORBIT PARAMS LDF OUTPUT FILES: MOON RISE/SET O/O CEL OBS DEFNS NDF CEL OBS AC/LOSS O/O	2.2 GENERATE MOON RISE/SET 3.5.1 DEVELOP CELESTIAL OBS DEFNS 3.5.2 GENERATE STELLAR OBS AC/LOS

SS MPS SOFTWARE REQUIREMENTS SUMMARY

SW MODULE NAME	NEW OR MODIFIED	SW MODULE FUNCTIONAL DESCRIPTION	APPLICABLE SUBFUNCTION/TASK
CAVA	MODIFIED	SEE SL MIPS DB-A LARGE PORTION OF SL MIPS CAVA IS DEVOTED TO HANDLING MANEUVER AND ATT TLS WHICH WILL NOT BE RQD FOR SS.THE ROUTINES APPLICABLE TO TRAJECTORY DATA,SENSOR DATA, TARGET DATA, SENSOR TARGET VISIBILITY, OCCULTATION AND FILE MGMT CAN BE USED WITH MODIFICATIONS AND A MODIFIED DRIVER. INPUT FILES: DTLD ORBIT PARAMS LDF OUTPUT FILES: TDRS AC/LOS O/O FILE	2.3 GENERATE TDRS COVERAGE
RADI2	MODIFIED	SEE SL MIPS DB-MUST READ DTLD ORBIT PARAMS FILE INSTEAD OF DTLD EPHEMERIS. INPUT FILES: DTLD ORBIT PARAMS LDF OUTPUT FILES:RAD ENVIR LDF	2.4 GENERATE RADIATION ENVIRONMENT
TANRAY	MODIFIED	SEE SL MIPS DB-MUST READ DTLD ORBIT PARAMS FILE INSTEAD OF MANUALLY INPUT STATE VECTOR INPUT FILES: DTLD ORBIT PARAMS LDF OUTPUT FILES: TANRAY EPHEM LDF.	3.1.1 COMPUTE DISTANCE FROM SS TO SUN LINE OF SITE TO EARTH SURFACE. COMPUTE SUN RISE/ SET HISTORY.
LTO	MODIFIED	SEE SL MIPS DB. IN THE SS MISSION PLANNING SYSTEM LTO WILL BE CALLED AT VARIOUS TIMES TO APPLY ACCEPTANCE CONDITIONS TO A LDF AND PRODUCE AN O/O FILE. MODIFICATIONS RQD WILL CONSIST PRIMARILY OF INTERFACES WITH THE VARIOUS SPECIAL OBSERVATION OPPORTUNITIES EXECUTIVES. INPUT FILES: ANY LIST DIRECTED FILE OUTPUT FILES: AN O/O FILE	3.1.2 DEVELOP/APPLY CONSTRS TO ATMOS PHYS OBS PERIODS 3.2.1 DEVELOP SUN ELEV CONSTRS FOR SOLAR OBS PERIODS 3.3.3 DEVELOP/APPLY EARTH OBS OPPS CONSTRS 3.4.3 DEVLP/APPLY CONSTRS TO BORB PARAMS 3.4.4 GENERATE HEMISPHERE OPPS 3.5.3 IMPOSE RADIATION CONSTRS
ATMOS	MODIFIED	SEE SL MIPS DB-WILL READ DTLD ORBIT PARAMS FILE INSTEAD OF ASCN NODE LDF AND EARTH SHADOW O/O FILES. CAPABILITY TO HANDLE VARIABLE ATTITUDES IS NO LONGER NEEDED.MODIFICATIONS RQD WILL CONSIST PRIMARILY OF INTERFACES WITH THE VARIOUS SPECIAL OBSERVATION OPPORTUNITIES EXECUTIVES. INPUT FILES: DTLD ORBIT PARAMS LDF OUTPUT FILES:SUN AZ/ELEV LDF	3.1.5 COMPUTE SUN AZ/ELEV FM SS WRT SUN RISE/SET EVENTS

SS MPS SOFTWARE REQUIREMENTS SUMMARY

SW MODULE NAME	NEW OR MODIFIED	SW MODULE FUNCTIONAL DESCRIPTION	APPLICABLE SUBFUNCTION/TASK
ATMOS PHYS EXEC	NEW	EXPERT SYSTEM EXECUTIVE THAT AIDS THE USER/MSN PLANNER IN DEFINING ATMOSPHERIC PHYSICS OBSERVATION RQMTS AND CALCULATING OBSERVATION OPPORTUNITIES. SYSTEM MUST PROVIDE A USER FRIENDLY INTERFACE WITH ON-LINE HELP AND EXPLANATION FEATURES. THIS EXECUTIVE SHALL SELECT AND SEQUENCE THE APPLICABLE CALCULATION ROUTINES (TANRAY, LTO, TARGEN, ATMOS). ACTUAL ROUTINE CALLS SHALL BE TRANSPARENT TO THE USER. THE USER SHALL BE PROVIDED WITH A "GENERIC" SET OF INPUT DEFAULT VALUES THAT ARE CONSTANTLY UPDATED BASED ON USER INPUTS TO OTHER FIELDS. THIS PROVIDES A WORKING MODEL OF USER OBS OPPS REQUIREMENTS REGARDLESS OF THE AMOUNT OF USER DEFINITION. THE EXECUTIVE SHALL HAVE THE CAPABILITY TO RECOGNIZE REQUESTS OUTSIDE ITS CURRENT KNOWLEDGE DOMAIN AND REQUEST ASSISTANCE FROM THE USER/OPERATOR.	3.1.6 EXEC FOR ATMOS PHYS OBS OPPS
ESDAT	MODIFIED	SEE SL MPS DB-GND SITE DEFNS WILL BE INPUT THROUGH EARTH SITE EXECUTIVE. INPUT FILES: NONE OUTPUT FILES: SITE AC/LOS O/O	3.3.1 CREATE EARTH SITE DEFN FILE
ESAL	MODIFIED	SEE SL MPS DB-WILL READ DTLD ORBIT PARAMS LDF INSTEAD OF ASCN NODE. INPUT FILES: SITE DEFNS NDF OUTPUT FILES: SITE AC/LOS O/O	3.3.2 GENERATE AREA SITE AC/LOS

SS MPS SOFTWARE REQUIREMENTS SUMMARY

SW MODULE NAME	NEW OR MODIFIED	SW MODULE FUNCTIONAL DESCRIPTION	APPLICABLE SUBFUNCTION/TASK
EARTH SITE EXEC	NEW	EXPERT SYSTEM EXECUTIVE THAT AIDS THE USER/MSN PLANNER IN DEFINING EARTH SITE OBSERVATION RQMTS AND CALCULATING OBSERVATION OPPORTUNITIES. SYSTEM MUST PROVIDE A USER FRIENDLY INTERFACE WITH ON-LINE HELP AND ALSO INTERFACE WITH THE APPLICABLE CALCULATION ROUTINES (ESDAT, ESAL, LTO,TARGEN,TAE). ACTUAL ROUTINE CALLS SHALL BE AS TRANSPARENT AS POSSIBLE TO THE USER. THIS EXEC CONTAINS FEATURES IDENTICAL TO THE ATMOS PHYS. EXECECUTIVE.	3.3.6 EXEC FOR EARTH SITE OBS OPPS
TAE	MODIFIED	SEE SL MIPS DB- STATISTICAL ANALYSIS ROUTINE WILL BE CALLED BY ORBITAL ANALYSIS EXECUTIVE PROGRAMS. O/O FILES WILL NOT BE REFORMATED AND BUILDING NEW SUBJECTS AND EDITING DATA WILL BE DONE IN THE O/O FILE FORMAT. MUST ALSO BE MODIFIED TO EXTRACT USER TIME PREFERENCES DIRECTLY FROM THE URDB. INPUT FILES: MSN OBS OPPS O/O OR URDB OUTPUT FILES: MSN OBS OPPS O/O	3.3.5 STATISTICAL ANAL OF OBS OPPS 3.4.6 STATISTICAL ANAL OF OBS OPPS 3.5.5 STATISTICAL ANAL OF OBS OPPS 5.1.1 EXTRACT USR TIME PREFERENCES 5.1.2 BUILD NEW SUBJECTS IF RQD 5.1.3 STATISTICAL ANALYSIS OF OBS OPPS 5.1.4 OBS OPPS DATA EDITING 6.1.1 EXTRACT USR TIME PREFERENCES 6.1.2 BUILD NEW SUBJECTS IF RQD 6.1.3 STATISTICAL ANALYSIS OF OBS OPPS 6.1.4 OBS OPPS DATA EDITING
BORB	MODIFIED	SEE SL MIPS DB-MODIFIED TO READ DTLD ORBIT PARAMS LDF INSTEAD OF ASCN NODE FILE. CAPABILITY TO HANDLE ATT TL O/O FILE IS NO LONGER REQUIRED. PROGRAM WILL BE DRIVEN BY PLAMSA PHYS EXECUTIVE. INPUT FILES:DTLD ORBIT PARAMS LDF OUTPUT FILES: BORB PARAMS LDF	3.4.1 COMPUTE ORIENTATION AND STRENGTH OF MAGNETIC FIELD IN SS BODY COORD SYS 3.4.2 DEVELOP PLASMA PHYSICS OBS DFNS

SS MPS SOFTWARE REQUIREMENTS SUMMARY

SW MODULE NAME	NEW OR MODIFIED	SW MODULE FUNCTIONAL DESCRIPTION	APPLICABLE SUBFUNCTION/TASK
PLASMA PHYS EXEC	NEW	EXPERT SYSTEM EXECUTIVE THAT AIDS THE USER/MSN PLANNER IN DEFINING PLASMA PHYS OBSERVATION RQMTS AND CALCULATING OBSERVATION OPPORTUNITIES. SYSTEM MUST PROVIDE A USER FRIENDLY INTERFACE WITH ON-LINE HELP AND ALSO INTERFACE WITH THE APPLICABLE CALCULATION ROUTINES. (BORB, LTO, TARGEN,TAE). ACTUAL ROUTINE CALLS SHALL BE AS TRANSPARENT AS POSSIBLE TO THE USER. THIS EXECUTIVE HAS FEATURES IDENTICAL TO THE ATMOS PHYSICS EXECUTIVE.	3.4.2 DEVELOP PLASMA PHYSICS OBS DEFNS 3.4.7 EXEC FOR PLASMA PHYS OBS OPPS
CELEST-IAL EXEC	NEW	EXPERT SYSTEM EXECUTIVE THAT AIDS THE USER/MSN PLANNER IN DEFINING CELESTIAL OBSERVATION RQMTS AND CALCULATING OBSERVATION OPPORTUNITIES. SYSTEM MUST PROVIDE A USER FRIENDLY INTERFACE WITH ON-LINE HELP AND ALSO INTERFACE WITH THE APPLICABLE CALCULATION ROUTINES (STAR, TARGEN, LTO, TAE). ACTUAL ROUTINE CALLS SHALL BE AS TRANSPARENT AS POSSIBLE TO THE USER. THIS EXECUTIVE HAS FEATURES IDENTICAL TO THE ATMOS PHYSICS EXECUTIVE.	3.5.6 EXEC FOR STELLAR OBS OPPS
VME	MODIFIED	SEE SL MIPS DB-INTERFACE MUST BE MODIFIED FOR COMPATIBILITIY WITH MODEL EDITOR EXECUTIVE. INPUT FILES: USER MDLS SS OPS CONSTRS DB OUTPUT FILES: ESS MODELS	5.2.3 EDIT USER MSN TL MODELS 5.2.4 BUILD CREW CYCLE SYSTEM MODELS 8.2.3 EDIT USER MSN TL MODELS 8.2.4 BUILD CREW CYCLE SYSTEM MODELS 7.3 ASSIGN USER RSC ENV ALLOCS

SS MPS SOFTWARE REQUIREMENTS SUMMARY

PAGE 6

SW MODULE NAME	NEW OR MODIFIED	SW MODULE FUNCTIONAL DESCRIPTION	APPLICABLE SUBFUNCTION/TASK
OBS OPPS EDITOR EXEC	NEW	EXPERT SYSTEM EXECUTIVE THAT GUIDES THE USER/MISSION PLANNER IN BUILDING SPECIAL OBSERVATION OPPORTUNITIES. ALLOWS USER TO INPUT REQUIRED OPERATING TIMES THAT ARE A RESULT OF SOMETHING OTHER THAN AN ORBITAL OPPORTUNITY. MUST INTERFACE WITH TAE ROUTINE THAT BUILDS NEW SUBJECTS. THE EXECUTIVE MUST HAVE THE ABILITY TO CONSTRUCT A VALID OBS OPPS SUBJECT IF REQUIRED, AND EXPLAIN THE PROCESS TO THE MISSION PLANNER. IT SHOULD BE CAPABLE OF ACTIVATING THE STATISTICAL ANALYSIS ROUTINE AND ASSESSING THE RESULTS FOR CONFIDENCE AND RELIABILITY OF THE OUTPUT WINDOW OF OBS OPPS.	5.1.5 OBS OPPS EDITOR EXEC 8.1.5 OBS OPPS EDITOR EXEC
MODEL EDITOR EXEC	NEW	EXPERT SYSTEM TO AID MISSION PLANNERS IN DEVELOPING MISSION TIMELINE MODELS. MUST PROVIDE INTERFACE WITH VME. THE EXECUTIVE SHOULD PERFORM ALL SOFTWARE MODULE SELECTION AND SEQUENCING AND PROVIDE GUIDELINES AND DEFAULT EXAMPLES FOR CONSTRUCTING TIMELINE MODELS. IT SHOULD MONITOR ALL TL MODELS FOR INTERNAL CONSISTENCY AND CONSTRAINTS. AN EXPLANATORY, USER FRIENDLY INTERFACE SHOULD BE PROVIDED.	5.2.5 MODEL EDITOR EXECUTIVE 8.2.5 MODEL EDITOR EXECUTIVE
MDL EXTRACT	NEW	INTERFACE WITH THE USER REQUIREMENTS DATA BASE AND EXTRACT THE APPROPRIATE USER TL MODELS DATA. INPUT FILES: URDB OUTPUT FILES: USER MODELS	5.2.1 EXTRACT USER TL MDLS FROM DB 8.2.1 EXTRACT USER TL MDLS FROM DB
MDL COMPARE	NEW	VERIFY COMPATIBILITY OF USER MODELS WITH USER RESOURCE ALLOCATIONS. INPUT FILES: USER MODELS USER RSC ENV ALLOCS OUTPUT FILES: USER MODELS	5.2.2 VERIFY COMPATIBILITY 8.2.2 VERIFY COMPATIBILITY

SS MPS SOFTWARE REQUIREMENTS SUMMARY

SW MODULE NAME	NEW OR MODIFIED	SW MODULE FUNCTIONAL DESCRIPTION	APPLICABLE SUBFUNCTION/TASK
SCHEDULER EXEC	NEW	EXPERT SYSTEM EXECUTIVE THAT WILL GUIDE MISSION PLANNERS AT BOTH THE PLANNING CENTERS AND PAYLOAD INTEGRATION CENTER IN USE OF ALL SCHEDULING SW MODULES. MAJOR MODULES WILL CONSIST OF A REVISED VERSION OF ESP, A NEW EXPERT RE-SCHEDULER AND VARIOUS UTILITY ROUTINES TO ALLOW COMBINING SCHEDULES, COMPARING SCHEDULES, AND GENERATING INTERFACE FILES ETC. MODULES AND UTILITY ROUTINES CURRENTLY IDENTIFIED ARE DISCUSSED INDIVIDUALLY. THE EXECUTIVE SHOULD MONITOR ALL I/O FOR CONSISTENCY AND INTERMODULE CONSTRAINTS. IT SHOULD BE CAPABLE OF PERFORMING CONFIDENCE ASSESSMENTS (E.G. 95%) OF ALL THE OUTPUT REQUIREMENTS AND IDENTIFY INPUTS THAT ARE NOT STRONGLY SUPPORTED BY THE CURRENT KNOWLEDGE BASE.	5.3.5 SCHEDULER EXECUTIVE 8.3.5 SCHEDULER EXECUTIVE
ESP	MODIFIED	SEE SL MIPS DB THE BASIC SCHEDULING PROCESS IS THE SAME AS SL MIPS ESP. THE CORE OF THE SCHEDULER SHOULD REQUIRE ONLY MINOR MODIFICATIONS. ADDITIONS/MODIFICATIONS WILL EXIST PRIMARILY IN THE AREAS OF INTERFACE FILES WITH THE ES RE-SCHEDULER AND THE OVERALL SCHEDULER EXECUTIVE. INPUT FILES: MSN OBS OPPS O/O ESS MODELS RESOURCE ALLOCS FILE(PLNG CTR BASIS OR PLD INTEG CTR BASIS) OUTPUT FILES: PLNG CTR GROSS USER OPS PLNG CTR CREW ACT PLANS INHB/CONSTR RQMTS SCHDLD USER RSC ALLOCS INTEG PLD CNSLDTD SCHDL	5.3.1 SCHED CREW CYCLE, SYSTEM MODELS 5.3.2 SCHED USER OPERATIONS 5.3.4 GENERATE OUTPUT 6.2 VFY COMPATIBILITY, IDENTIFY DEVIATIONS 6.4 EXTRACT RESOURCE REQUIREMENTS 8.3.1 SCHED CREW CYCLE, SYSTEM MODELS 8.3.2 SCHED USER OPERATIONS 8.3.4 GENERATE OUTPUT 9.3 VERIFY COMPATIBILITY WITH SS OPS 9.4 IDENTIFY CONFLICTS ACROSS PLNG CTRS 9.6 GENERATE INTGD PLD TOP 10 GENERATE USER ACTIVITY PLANS 11.3 VERIFY RSC AND OPS CONSTRS CONFLICTS 11.5 GEN PLNG CTR ACT PLAN 12.3 PERFORM INTEGRATED RSC CHECK/IDENTIFY CONFLICTS 12.5 GENERATE INTEG'D PYLD ACT PLAN

SS MPS SOFTWARE REQUIREMENTS SUMMARY

PAGE 8

SW MODULE NAME	NEW OR MODIFIED	SW MODULE FUNCTIONAL DESCRIPTION	APPLICABLE SUEFUNCTION/TASK
TL COMPARE	NEW	UTILITY ROUTINE THAT WILL COMPARE--AND IDENTIFY DEVIATIONS--A RESOURCE ALLOCATIONS PROFILE WITH A SCHEDULE THAT WAS DEVELOPED TO FIT WITHIN THOSE ALLOCATIONS FOR VERIFICATION PURPOSES. MUST INTERFACE UPWARDS WITH THE SCHEDULER EXECUTIVE. INPUT FILES: RESOURCE ALLOCATION FILES ESS TL FILES(USERS OR PLNG CTRS) OUTPUT FILES: VERIFIED ESS TL FILES WITH DEVIATIONS	7.1 COMPARE, IDENTIFY DEVIATIONS 9.1 VERIFY COMPATIBILITY, IDENTIFY DEVIATIONS 11.1 VERIFY COMPATIBILITY,IDENTIFY DEVIATIONS 12.1 VERIFY COMPATIBILITY, IDENTIFY DEVIATIONS
TL MERGE	NEW	UTILITY ROUTINE THAT WILL CONSOLIDATE VERIFIED SCHEDULES/TIMELINES INTO AN INTEGRATED SCHEDULE OF THE ESS FORMAT. MUST INTERFACE UPWARDS WITH THE SCHEDULER EXECUTIVE. INPUT FILES: ESS TL FILES OUTPUT FILES: CONSOLIDATED ESS TL FILES	6.1 CONSOLIDATE REQUIREMENTS 9.2 CONSOLIDATE PLANNING CTR TOPS 11.2 CONSOLIDATE USER ACT PLANS 12.2 CONSOLIDATE PLNG CTR ACT PLANS
CMD PLANNER	NEW	USER FRIENDLY EDITOR TO GUIDE/ASSIST USERS IN BUILDING USER SPECIFIC COMMAND LISTS COMPLETE WITH DELTA TIMES. ALSO TAKES ACTVITY PLANS AS INPUT AND TIMETAGS COMMAND LISTS WITH ABSOLUTE TIMES. THE EXECUTIVE SHOULD RELY ON INPUT FROM THE URDB TO ASSEMBLE RECOMMENDED COMMAND SEQUENCES BASED ON CONSTRAINTS AND THE CURRENT EXPERIENCE BASE. IT SHOULD ALSO BE ABLE TO PERFORM REORGANIZATION OF GROUPS OF COMMANDS BASED ON USER INPUTS. INPUT FILES: URDB USER ACTIVITY PLANS DB OUTPUT FILES: USER CMD PLANS DB	13.1 CREATE COMMAND LIST 13.2 PRODUCE TIMETAGS 13.3 GENERATE CMD TL OUTPUT

SS MPS SOFTWARE REQUIREMENTS SUMMARY

SW MODULE NAME	NEW OR MODIFIED	SW MODULE FUNCTIONAL DESCRIPTION	APPLICABLE SUBFUNCTION/TASK
RE-SCHED-ULER	NEW	THIS MODULE IS AN EXPERT SYSTEM THAT WILL TAKE A SCHEDULE/TIMELINE GENERATED BY ESP AND ALLOW RE-SCHEDULING OF OPERATIONS TO REFINE THE ORIGINAL SCHEDULE, MAKE CHANGES REQUIRED AS A RESULT OF OVERALL PAYLOAD INTEGRATION OR ALLOW ON-BOARD RE-SCHEDULING BY THE CREW. THIS MODULE WILL READ AN ESS FORMATED TIMELINE, AID THE OPERATOR IN RE-SCHEDULING OPERATIONS AND CREATE AN OUTPUT FILE IN THE ESS FORMAT. PLANNET AND MAESTRO ARE POTENTIAL BASELINE MODELS FOR THIS MODULE. SINCE PLANS ARE FOR ONE VERSION OF THIS MODULE TO RESIDE ON-BOARD THE SS RQMT THAT ALL FLIGHT SW BE WRITTEN IN ADA MUST BE CONSIDERED. INPUT FILES: ESS TL FILES ESS MODEL FILES OUTPUT FILES: UPDT'D ESS TL FILES	5.3.3 RE-SCHEDULE USER OPS(ES) 8.3.3 RE-SCHEDULE USER OPS(ES) 9.5 RE-SCHEDULE USER OPS TO ELIMINATE CONFLICTS BETWEEEN PLNG CTRS 11.4 RE-SCHEDULE OPS TO ELIMINATE CONFLICTS BETWEEN USERS 12.4 RE-SCHEDULE OPS TO ELIMINATE CONFLICTS BETWEEN PLNG CTRS 15.1 ON-BOARD RE-SCHEDULING
PCAP	MODIFIED	SEE SL MIPS DB- SS OPERATIONS MAY IMPOSE NEW RQMTS ON THE LAYOUT OF THE PCAP CHARTS. INTERFACE FILES WILL BE SOMEWHAT DIFFERENT AND HARDCOPY OUTPUT WILL BE OPTIONAL. INPUT FILES: CREW PRCDRS DB ESS MODELS FILE PLNG CTR USER OPS MSN OBS OPPS O/O OUTPUT FILES: PCAP CHARTS FILE NOTES FILE PROCEDURES FILE	11.6.1 GENERATE PCAP CHARTS
PTS	MODIFIED	SEE SL MIPS DB- SS OPERATIONS MAY IMPOSE NEW RQMTS ON THE LAYOUT OF THE PTS CHARTS. INTERFACE FILES WILL BE SOME-WHAT DIFFERENT AND HARDCOPY OUTPUT WILL BE OPTIONAL. INPUT FILES: PLNG CTR CREW ACT PLANS DTLD ORBIT PARAMS LDF INHB/CONSTR RQMTS PLNG CTR USER OPS MSN OBS OPPS O/O OUTPUT FILES: PTS CHARTS FILE	11.6.2 GENERATE PTS CHARTS

SS MPS SOFTWARE REQUIREMENTS SUMMARY

SW MODULE NAME	NEW OR MODIFIED	SW MODULE FUNCTIONAL DESCRIPTION	APPLICABLE SUBFUNCTION/TASK
SUMMARY PCAP	NEW	PROGRAM THAT WILL GENERATE A SUMMARY PCAP FROM THE CONSOLIDATED PAYLOAD OPERATIONS SCHEDULE AND THE DETAILED PLANNING CENTER DAILY PCAPS. INPUT FILES:DTLD PLNG CTR DAILY PCAP CNSLDTD PYLD ESS TL FILE OUTPUT FILES: PYLD SUMRY PCAP	12.6 GENERATE INTEGRATED PAYLOAD SUMMARY PCAP
PCAP DELTAS	NEW	ON-BOARD SW THAT WILL, AFTER CREW CHANGES ARE MADE TO THE INDIVIDUAL PLANNING CENTER TIMELINES, MODIFY THE EXISTING ON-BOARD PCAP, SEND THE UPDATED PCAP TO THE ON-BOARD SS ACTIVITY PLANS DATA BASE AND DOWNLINK A DELTAS FILE THAT WILL ALLOW GROUND PERSONNEL TO UPDATE THEIR VERSION OF THE PCAP. INPUT FILES: PLNG CTR DTLD DAILY PCAP ESS TL FILE OUTPUT FILES: UPDT'D PLNG CTR DTLD PCAP PLNG CTR DTLD PCAP DELTAS PYLD SUMRY PCAP	15.2 UPDATE PLNG CTR DTLD PCAP
PLNG CTR MISSION PLNG EXEC	NEW	PHASE I: A HIGH LEVEL EXECUTIVE WHICH PROVIDES MISSION PLANNING PERSONNEL A STANDARDIZED SYSTEM FOR USE OF LOWER LEVEL EXECUTIVES AND CALCULATION ROUTINES AS WELL AS PROVIDING A FILE MANAGEMENT SYSTEM. THE NATURAL LANGUAGE INTERFACE DESCRIBED IN THE USER PLANNING EXECUTIVE WILL BE AVAILABLE WITH A VOCABULARY TAILORED TO THE PLANNING CENTER APPLICATIONS. PHASE II: CAPABILITY WILL BE PROVIDED SUCH THAT LOGIC MAY BE ENCODED IN SUBFUNCTIONS 5, 7, 8 AND 10 OF PLANNING CYCLES A, B, AND C AND USED AS AN ADVISOR IN SUBFUNCTIONS 8 AND 10 OF THE REPLANNING CYCLE D.	

SS MPS SOFTWARE REQUIREMENTS SUMMARY

SW MODULE NAME	NEW OR MODIFIED	SW MODULE FUNCTIONAL DESCRIPTION	APPLICABLE SUBFUNCTION/TASK
PYLD OPS INTEG. CTR MSN PLNG EXEC	NEW	PHASE I: A HIGH LEVEL EXECUTIVE WHICH PROVIDES MISSION PLANNING PERSONNEL A STANDARDIZED SYSTEM FOR USE OF LOWER LEVEL EXECUTIVES AND CALCULATION ROUTINES AS WELL AS PROVIDING A FILE MANAGEMENT SYSTEM. SIMILAR TO THE PLNG CTR VERSION. PHASE II: CAPABILITY WILL BE PROVIDED SO THAT LOGIC MAY BE ENCODED DURING SUBFUNCTIONS 6, 9, 11, AND 12 OF PLANNING CYCLES A, B, C AND USED AS AN ADVISOR IN SUBFUNCTIONS 6, 11, AND 12 OF THE REPLANNING CYLE D.	
SPECIAL OBS OPPS EXEC	NEW	A HIGH LEVEL EXECUTIVE THAT INTERFACES UPWARDS TO THE USER AND PLANNING CENTER MISSION PLANNING EXECUTIVES AND DOWNWARD TO THE INDIVIDUAL DISCIPLINE OBSERVATION OPPORTUNITIES EXECUTIVES. THE BASIC FUNCTION IS TO IDENTIFY THE APPLICABLE DISCIPLINE(S) IMPLIED BY THE USER INPUT OBS OPPS DEFINITIONS. THE APPLICABLE DISCIPLINE EXECUTIVES ARE ACTIVATED TO PROVIDE THE DETAILED OBS OPPS DEFINITION. OTHER MODULES ARE POLLED TO IDENTIFY ANY POSSIBLE CONSTRAINTS. THE EXECUTIVE SHALL PROVIDE A USER FRIENDLY INTERFACE WITH BUILT IN TRAINING AND EXPLANATION FEATURES. IT SHALL BE ABLE TO ORGANIZE AND MANIPULATE THE OBS OPPS SETS FOR BEST FIT EVALUATIONS BY THE USER. IT SHALL BE ABLE TO TAG SELECTED SETS FOR LATER RECALL BY THE MISSION PLANNER.	3.7 TOP LEVEL SPECIAL SPECIAL OBS OPPS EXECUTIVE 3.8 EXTRACT USER OBS OPPS RQMTS DATA

SS MPS SOFTWARE REQUIREMENTS SUMMARY

SW MODULE NAME	NEW OR MODIFIED	SW MODULE FUNCTIONAL DESCRIPTION	APPLICABLE SUBFUNCTION/TASK
USER MSN PLNG EXEC	NEW	PHASE I: A HIGH LEVEL EXECUTIVE THAT PROVIDES A USER FRIENDLY INTERFACE FOR SS USERS TO THE USER MISSION PLANNING SOFTWARE RESIDENT AT THE PLANNING CENTERS. THE EXECUTIVE WILL PROVIDE CURRENT MISSION INCREMENT INFORMATION SUCH AS DATES/TIMES WHEN USER RQMTS/DETAILED SCHEDULES MUST BE COMPLETED, A GENERAL OVERVIEW OF THE MISSION PLANNING PROCESS AND PROVIDE A HIGH LEVEL GUIDE TO THE USE OF THE APPROPRIATE MISSION PLANNING SW MODULES. THE USER SHALL BE ABLE TO DIALOG WITH THE EXECUTIVE VIA A NATURAL LANGUAGE INTERFACE. THE EXECUTIVE MUST BE ABLE TO MAKE ASSUMPTIONS RELIABLY AND PERFORM CONSISTENCY AND CONSTRAINT CHECKING ON ALL USER INPUT/OUTPUT. IT MUST BE CAPABLE OF RECOGNIZING ITS KNOWLEDGE DOMAIN LIMITATIONS AND REQUESTING USER/OPERATOR ASSISTANCE WHEN REQUIRED. PHASE II: ADD THE CAPABILITY FOR THE EXECUTIVE TO EXTRACT THE REASONING BEHIND THE INPUT DECISIONS SPECIFIED BY THE USER. THESE REASONS WILL BE ENCODED AND MODELED FOR USE IN AN ADVISORY CAPACITY DURING THE MISSION REPLANNING CYCLE.	

SS MPS SOFTWARE REQUIREMENTS SUMMARY PAGE 13

SW MODULE NAME	NEW OR MODIFIED	SW MODULE FUNCTIONAL DESCRIPTION	APPLICABLE SUBFUNCTION/TASK
SOLAR EXEC	NEW	EXPERT SYSTEM EXECUTIVE THAT AIDS THE USER/MSN PLANNER IN DEFINING SOLAR OBSERVATION RQMTS AND CALCULATING OBSERVATION OPPORTUNITIES. SYSTEM MUST PROVIDE A USER FRIENDLY INTERFACE WITH ON-LINE HELP AND EXPLANATION FEATURES. THIS EXECUTIVE SHALL SELECT AND SEQUENCE THE APPLICABLE CALCULATION ROUTINES (LTO, TARGEN). ACTUAL ROUTINE CALLS SHALL BE TRANSPARENT TO THE USER. THE USER SHALL BE PROVIDED WITH A "GENERIC" SET OF INPUT DEFAULT VALUES THAT ARE CONSTANTLY UPDATED BASED ON USER INPUT TO OTHER FIELDS. THIS PROVIDES A WORKING MODEL OF USER OBS OPPS REQUIREMENTS REGARDLESS OF THE AMOUNT OF USER DEFINITION. THE EXECUTIVE SHALL HAVE THE CAPABILITY TO RECOGNIZE REQUESTS OUTSIDE ITS CURRENT KNOWLEDGE DOMAIN AND REQUEST ASSISTANCE FROM THE USER/OPERATOR.	3.2.3 EXEC FOR SOLAR OBS OPPS
OUTPUT PROCESS-OR EXEC	NEW	EXECUTIVE PROGRAM THAT AIDS THE MISSION PLANNER IN THE USE OF THE PTS, PCAP, AND SUMMARY PCAP PROGRAMS. MUST INTERFACE UPWARDS WITH THE PLANNING CENTER AND PAYLOAD OPERATIONS INTEGRATION CENTER SYSTEM EXECUTIVES.	

SS MPS SOFTWARE REQUIREMENTS SUMMARY

PAGE 14

SW MODULE NAME	NEW OR MODIFIED	SW MODULE FUNCTIONAL DESCRIPTION	APPLICABLE SUBFUNCTION/TASK
URDB I/F	NEW	EXPERT SYSTEM THAT GUIDES/PROMPTS USERS IN ENTERING FUNCTIONAL REQUIREMENTS INTO THE DATA BASE TO PROVIDE MISSION PLANNERS THE APPROPRIATE INFORMATION FOR PLANNING AND SCHEDULING. THE SYSTEM SHOULD ALLOW INTERACTIVE FORM EDITING BY THE USER WITH ON-LINE HELP, DATA ENTRY RULES AND MEANINGFUL DEFAULT VALUES. THE TYPES OF REQUIREMENTS TO BE INCLUDED ARE; RQD RESOURCE VECTORS (POWER, CREW,THERMAL, DATA,ETC.); RQD OBSERVATIONS DEFINITIONS; OPERATIONAL CONSTRAINTS(INHIBITS, ETC.); SEQUENCING,CONCURRENCY RQMTS; AND MIN/MAX #OF PERFORMANCES, DURATIONS. THE DB INTERFACE MUST PROVIDE THE CAPABILITY TO RECOGNIZE REQUESTS/INPUTS OUTSIDE OF ITS KNOWLEDGE DOMAIN AND REQUEST HUMAN EXPERT ASSISTANCE WHEN KNOWLEDGE BASE IS INADEQUATE. THE SYSTEM SHOULD BE ABLE TO INTELLIGENTLY UPGRADE DEFAULT VALUES BASED UPON LATEST INPUT DATA FROM USER. THE SYSTEM SHOULD GENERALIZE LOWER LEVEL DETAILS INTO UPPER LEVEL REQUIREMENTS. ALL REQUIREMENTS SHOULD BE CHECKED FOR CONSTRAINTS IN ALL SIX DISCIPLINES. OUTPUT REQUIREMENTS SHALL HAVE ALL ASSUMPTIONS NOTED AND CONFIDENCE FACTORS (E.G. 90%) ASSIGNED.	4 USER REQUIREMENTS DATA BASE I/F

Section 7

TASK 4 - INVESTIGATE ARTIFICIAL INTELLIGENCE APPLICATIONS

7.1 ACTIVITIES AND ACCOMPLISHMENTS

The objectives of this task were to:

(1) Define AI techniques that could be applied to SS MPS tasks.
(2) Identify and evaluate all tasks that could use the AI techniques.
(3) Recommend a methodology for implementation of the identified AI tasks.

These objectives were accomplished as illustrated in Figure 7.1-1. Two areas of effort contributed to accomplishment of the objectives specified above. The first effort was to conduct a survey of the current AI technology. The second effort was to compile a list of desired criteria for an AI software development program. Both efforts increased the quality and scope of the recommended hardware and software methodology.

7.2 DEFINITION OF ARTIFICIAL INTELLIGENCE

Artificial Intelligence is the emulation of human intelligence and thought processes by computational models. It is the branch of Computer Science concerned with designing intelligent computer systems that exhibit the characteristics associated with intelligence in human behavior - reasoning, understanding language, solving problems, etc.

Expert systems are AI programs that are designed to execute a highly specialized and difficult task with the proficiency of a human expert. They employ domain-specific problem-solving strategies as opposed to broad, general-purpose strategies.

7.3 SURVEY OF AI TECHNOLOGY

A limited survey was conducted of the efforts of various companies and Government agencies to summarize the type of problems that were being solved with AI techniques and the degree of success in their performance. Three areas of the technology were addressed: expert systems, natural language interfaces, and automatic programming. Expert systems were categorized into training and instruction, trending and prediction, design and configuration, information and data interpretation, and planning and scheduling.

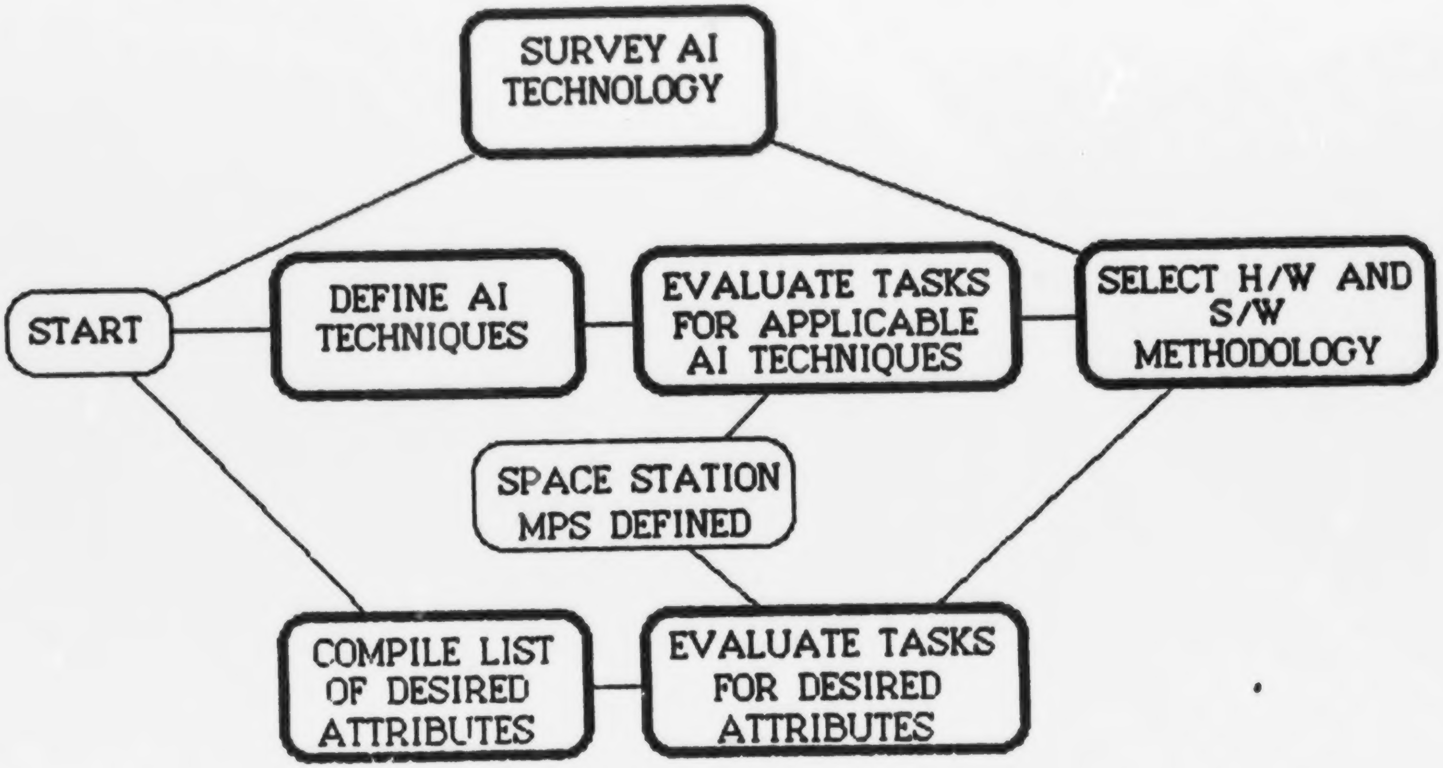
7.3.1 Expert Systems

7.3.1.1 Training and Instruction

The Army Missile Command Research and Development Center successfully deployed an expert system to train operators in the use of an air defense system. It was prototyped with a commerically available expert system tool on an IBM PC and then ported to a larger mainframe. The system performs off-line simulations to improve operator proficiency and provide advisory functions during actual real-time situations.

FIGURE 7.1-1

TASK 4 FLOW CHART


SURVEY AI TECHNOLOGY
START
DEFINE AI TECHNIQUES
EVALUATE TASKS FOR APPLICABLE AI TECHNIQUES
SELECT H/W AND S/W METHODOLOGY
SPACE STATION MPS DEFINED
COMPILE LIST OF DESIRED ATTRIBUTES
EVALUATE TASKS FOR DESIRED ATTRIBUTES

7.3.1.2 Trending and Prediction

The KNOMES system designed by MDAC-Huntington Beach is a hierarchical object-oriented program that performs fault isolation, correction and prediction. It is implemented in ADA on the VAX and has been tested on the SS Data Management System test bed at NASA JSC.

The Systems Autonomy Demonstration Program funded by NASA Ames Research Center has designed several subsystems using autonomous control modules.

Autonomous control is the goal of the NASA Goddard Research Center in designing controllers for the Space Station power distribution system.

The Navigation Subsystem Technical Assistant, designed by Boeing Seattle for the USAF, monitors GNC data and provides recommended actions to the human operator. It was implemented in prototype on an IBM PC using the Personal Consultant shell from Texas Instruments.

The STALEX system designed by NASA JSC performs launch window selection given the many time-dependent factors of orbital mechanics and ground tracking site availabilities.

7.3.1.3 Design and Configuration

The most renowned configuration expert system in the industry is Digital Equipment Corporation's XCON, formerly called R1. It is implemented in OPS5 on the VAX. XCON specifies a detailed computer hardware configuration, including integration and test instructions, from an input of customer requirements.

The KATE system from NASA KSC is currently being prototyped to capture the design knowledge of the existing LES expert system. LES allows the generator to access all electrical schematics of the LOX fueling system of the Shuttle. The KATE system will allow a higher level of user interface to this data base and promote faster electrical redesign. KATE is being implemented on IBM PC/AT's.

The HICLASS system from Hughes Aircraft is tailored to CAD/CAM applications. It was originally coded in FORTRAN and SPL, later converted to PASCAL running on the HP 3000. It has lately been re-coded into C on the Apollo workstations under the Unix operating system.

7.3.1.4 Information and Data Interpretation

The EAGLE system, developed at INCO (a MDAC subsidiary), processes large quantitities of numerical and qualitative data to provide advisory information to Air Force operators in the NORAD system. The initial prototype was implemented in LISP using KEE on the Symbolics machine.

The XSEL system in use at DEC is the front end processor for the XCON system mentioned above. It interprets multiformat input data from the customer and outputs standardized configuration requirements.

7.3.1.5 Planning and Scheduling

The KNOMES system from MDAC-HB includes several expert system routines devoted to planning and scheduling for the Space Station.

The MARS system, formerly PLANNET, from MDAC-Kennedy Space Center Division, has been implemented in several prototypes to schedule Shuttle payload integration operations for the entire O&C building. It is implemented in LISP on a Symbolics machine.

The PLAN-IT system from NASA JPL was derived from Voyager mission experiment scheduling. Modules applicable to Spacelab mission planning to are currently being sought. PLAN-IT is implemented in LISP on a Symbolics machine.

The MAESTRO system for Martin Marietta Corporation addresses the problem of experiment scheduling for the Space Station. It is implemented in LISP on a Symbolics machine.

The Space Station Expert System from Lockheed in Houston is a scheduling system prototype to provide on-board advice to operators for reconfiguring resources to meet a hazardous or unexpected event.

7.3.2 Natural Language Interfaces

Intellect, from Artificial Intelligence Corporation, was one of the first NLI's available for information retrieval from existing data bases in finance, businesses and marketing. Lifer is a follow up to the Intellect tool. It facilitates queries to conventional data bases.

Language Craft is a tool available from Tecknowledge. It is implemented on the Symbolics machine.

Chat-80 is a NLI developed at Stanford and marketed by SRI. It is implemented in Prolog on the Symbolics machine.

Savvy is a tool from a MDAC subsidiary that is implemented on an IBM PC/XT.

7.3.3 Automatic Programming

The ABE system, being developed by Technowledge for DARPA, is a comprehensive attempt to gather an assortment of existing AI tools, languages and techniques, and to develop a system that will allow an operator to assemble expert systems at a high level. The languages contained thus far are: Common LISP, MRS, Knowledge Craft and S1. The logic frameworks include: Blackboards, Data Flow Paths, Intermodule Transaction, and Data Importer. The total system is still in a prototype phase.

7.4 ASSUMPTIONS PRIOR TO CANDIDATE EVALUATION

Experience gained from the early phases of the project allowed several assumptions to be made prior to evaluation of the SS MPS candidates.

7.4.1 ADA Software

It is assumed that all new non-AI mission planning software tasks will be coded in ADA for compatibility with Space Station program requirements.

All AI techniques can be implemented in LISP, PROLOG or ADA. LISP and PROLOG have only a few advantages over ADA, as explained in subsection 7.7 below.

7.4.2 Specialized AI Hardware

If specialized AI hardware is required, assume a Symbolics architecture. LISP and PROLOG are not viable languages unless executed on specialized AI processors. Symbolics is the best processor currently on the market.

The execution of LISP on coprocessor boards installed in conventional computers is not considered; however, their emergence on the market is imminent.

7.4.3 Conventional Hardware

Assume a DEC VAX architecture for all ADA software implementations.

7.4.4 Candidate Evaluation Criteria

The criteria for candidate evaluation are not discrete. They are frequently interrelated.

The criteria are qualitative rather than quantitative. Also, not all criteria are of equal importance.

The evaluation of each software set against the criteria is subjective. The evaluation is highly dependent on definitive information about AI techniques and Space Station operations concepts.

7.5 DESIRED ATTRIBUTES OF MPS TASKS

This list of desired attributes is based upon industry accepted standards for a software development project. Several attributes have been added or modified to tailor them to software projects employing AI techniques.

The desired attributes for candidate MPS tasks are shown in Figure 7.5-1. Each software set received a "+" if the set contained the desired attribute and a "-" if the attribute was missing and could cause potential problems in the implementation of the task.

7.5.1 Task Domain

Domain Knowledge Base is Bounded and Stable

The knowledge base required to accomplish the task must be bounded to have some defined limits; otherwise, the software data base is

FIGURE 7.5-1

ATTRIBUTES OF MPS TASKS

TASK GROUP

	A	B	C	D	E	F	G	H	I	J	K	L
TASK DOMAIN												
Domain is bounded and stable	+	-	+	+	-	-	+	+	+	+	-	-
Domain is specialized and detailed	+	+	+	+	+	-	-	+	+	+	+	+
TASK EXPERTISE												
Expertise to be lost	+	+	+	+	+	+	-	+	+	+	+	+
Expertise is scarce	+	+	-	+	+	+	-	+	+	+	+	+
Single point expert	+	-	+	+	-	-	-	+	+	+	+	+
Expert is dedicated	+	+	+	+	-	-	+	+	+	+	+	+
TASK INTERFACES AND METHODS												
System can monitor real world	+	-	+	+	-	-	-	+	+	+	+	+
I/O and methods can be defined	-	-	+	-	+	-	-	+	+	+	+	+
Debugging the software	+	+	+	+	-	-	+	+	+	+	+	+
ORGANIZATIONAL ISSUES												
Required Documentation	+	+	+	+	+	+	+	+	+	+	+	+
Configuration control	+	+	+	+	+	+	+	+	+	+	+	+
System acceptance testing	+	-	+	+	-	-	+	+	+	+	+	+
MANAGEMENT ISSUES												
Realistic schedules and milestones	+	+	+	+	-	-	+	+	+	+	+	+
Resource comittment	+	+	+	+	+	+	+	+	+	+	+	+
Low initial cost	+	-	+	-	-	-	+	+	+	+	+	+
Long term manhour savings	+	+	-	+	+	+	-	+	+	+	+	+
PROPOSED USERS OF TASK												
User acceptance	+	-	+	+	-	-	+	+	+	+	+	+

SOFTWARE SETS

A - SPECIAL OBS OPPS EXECUTIVES
B - USER REQUIREMENTS DATA BASE INTERFACE
C - EDITOR EXECUTIVES
D - RESCHEDULER
E - SYSTEM EXECUTIVES PHASE I
F - SYSTEM EXECUTIVES PHASE II
G - COMMAND PLANNER
H - NEW TIMELINE SOFTWARE
I - MODIFIED TIMELINE SOFTWARE
J - MODIFIED ORBITAL MECHANICS SOFTWARE
K - MODIFIED DATA FLOW SOFTWARE
L - OUTPUT PROCESSOR EXECUTIVE

never complete and a goal state for project completion is impossible to define. Object oriented programming styles can alleviate this problem somewhat by providing a workable system by declaring objects or modules to deal with input that is outside the current domain. These objects would contain generic methods and generic rules that cover all possible cases. This will allow the system to "soft fail" when confronted with an inquiry outside the task's domain. However, this type of program is likely to be in a state of constant revision.

The knowledge base must also be stable; otherwise, when the system is released, it is already out of date. Frequent mandatory updates to the knowledge base detract from the manpower savings realized from initially automating the task.

Domain Knowledge Base is Specialized and Detailed

Assuming that the task domain is bounded, the ideal domain should consist of specialized knowledge instead of a broad expanse of general knowledge. Specialized knowledge usually lends itself to representation using one or two programming techniques, thus reducing the modeling task complexity.

Detailed knowledge implies that the task contains some expertise (is not a trivial problem), and is therefore worth the effort to code the task.

7.5.2 Task Expertise

Expertise to be Lost

If the expert now performing the task will soon be retiring, advancing, etc., and it will be difficult and expensive to train another expert, then automation may be justified.

Expertise is Scarce

If the expert could be useful in many different locations at the same time, then automation and duplication may be justified.

Single Point Expert

A few people, or preferably one person, must be designated as the domain expert. Multiple experts cause problems such as conflict of information, and organization of segments of knowledge from different experts.

Expert is Dedicated

The expert must be able to suspend his normal duties when needed to assist on the project. This may be difficult since true experts usually have a high demand for their time. Of course, the expert must possess the communications skills to have his knowledge encoded correctly and possess the patience to verify that the system performs correctly. The expert must be interested in the success of the project.

7.5.3 Task Interfaces and Methods

System Can Monitor State of the Real World

All significant communications from the user must be capable of capture by the system. For example, current systems are not capable of capturing facial expressions and voice inflections of a human. The system will contain a model of the real world (within its domain limitations) that it can use to formulate responses. This model must be easily updated by the user (keyboard, voice recognition, etc.). Manual data entry is not a task that humans perform efficiently; preferable interfaces are with automatic stimuli (data stream from other computers, sensors, etc.).

Input, Output and Methods Can be Defined

The expert or pool of experts must be able to define "acceptable" input and output. An expert(s) must be able to define the scope of the task and the methods used to perform the task. The AI capability of rapid prototyping can be cost effective in the early phases of requirements definition to define the methods.

Debugging the Software

During the design phase, unexpected responses by the software are still difficult to detect and isolate. In conventional code, paths of procedural flow may occur that the designer never intended nor had perceived. This is becoming less of a problem for conventional software with improved editors and debuggers. In LISP and especially PROLOG, similar bugs may exist as loops in the knowledge base which cause incorrect assumptions. LISP and PROLOG editors and debuggers are also very powerful and improving. This problem seems to be based on the complexity of the task rather than the choice of software language for implementation.

7.5.4 Organizational Issues

Required Documentation

Automation reduces the amount of documentation required by the user to complete the task, but it necessitates creation of a new set of documentation for maintenance of the new hardware and software. This documentation must describe in detail the implementation of the task on the machine.

Documentation also includes comment lines within the source code. Contrary to rumors about the readability of LISP and PROLOG, these AI languages must contain complete comments to code just as in conventional languages.

Note in Figure 7.5-1 that is an applicable desired attibute for all MPS tasks; therefore, it does not, in effect, serve to identify automated over manual or AI over non-AI tasks.

Configuration Control

Machine hardware and software and the documentation must all be kept in a known state to all users and development and maintenance personnel. Revisions to the hardware and software must be controlled and tracked. A configuration management system is established after early prototyping but prior to Preliminary Design Review. That system continues throughout the life of the project.

This desired attibute is also applicable for all MPS tasks and therefore does not serve to identify automated over manual or AI over non-AI tasks.

System Acceptance Testing

Initial release of the system must be accompanied by testing adequate to provide confidence that the system performs as expected. The test cases used are typically "worst case" or "average" scenarios. If the range of real world problems that the system will encounter is difficult to approximate, then the amount of acceptance testing will be very large in order to obtain a satisfactory level of confidence in the system's performance.

7.5.5 Management Issues

Realistic Schedules and Milestones

A realistic schedule for project completion should contain adequate time for all phases of software development and requirements definition and design. (For example, adequate time may not exist to clearly define the methods to be automated to accomplish MPS tasks previously performed manually.) Significant milestones should be established at the beginning of the project. The level of system performance at these milestones should be well defined to avoid ambiguity about the progress of the system.

The final acceptance milestone should include the explicit definition of "project success".

All milestones serve to verify that the system is developing toward the desired target and to rekindle controlling management's interest and awareness in the project.

Resource Commitment

The necessary resources must be committed, by management, to the project. Budget must be allocated for hardware and software purchases, adequate facilities must be designated, and necessary manpower skills must be committed. (It is assumed that is an applicable desired attribute for all MPS tasks and therefore does not serve to identify automated over manual or AI over non-AI tasks.)

Low Initial Cost

Automation frequently requires a large "up front" investment of capital equipment and man hours. It may take several years of savings from automation to recover the initial cost. Obviously a low initial cost is preferred to a high one.

Long Term Manhour Savings

The goal of automation is to alleviate humans of the mechanics of performing a task, that they may spend their time in a more cost efficient task. The time required by the user to operate and maintain the system must not exceed the time required to do the task manually for automation to be considered successful.

7.5.6 Proposed Users Of Task

User Acceptance

Unless the system is accepted by the end users it will be ignored and abandoned.

The ideal delivered system should fit into the user's daily routine, impose few new requirements, and demand little or no training in its use or interpretation.

There must be an efficient feedback method from the users to the system designers and maintainers. Ideally the users should maintain the system.

The users must trust the system output. This can be facilitated by heavily involving the users in the design process. The Explanation Capability of AI systems is a good technique to enhance credibility in the eyes of the users.

7.6 ARTIFICIAL INTELLIGENCE TECHNIQUES

An attempt was made to comb through the many books describing AI techniques and pull out the techniques that demonstrate advantages over conventional programming techniques.

The definition of an AI technique versus a conventional technique is subjective and a source of disagreement within the programming community. The boundary between the two is constantly shifting. Many AI techniques were first implemented in LISP or PROLOG and then found their way to conventional implementations in FORTRAN, PASCAL or C. For our definition, AI techniques are most easily implemented in ADA, LISP or PROLOG, while implementations in FORTRAN, etc., are considered to be strictly conventional. Note that ADA holds the middle ground, being a derivative of PASCAL and FORTRAN, but designed to easily implement complex AI techniques.

The following paragraphs describe the AI techniques identified as advantageous over conventional programming techniques. These techniques are listed on Figure 7.6-1. The functions of each software set were evaluated against the list and given a "+" if any of the task functions could be implemented using an AI technique.

FIGURE 7.6-1

AI TECHNIQUES FOR MPS TASKS

	TASK GROUP											
	A	B	C	D	E	F	G	H	I	J	K	L
REPRESENTATION OF KNOWLEDGE												
Production Rules	+	+	+	+	+	+	+		+		+	+
State space representations				+		+						
Frames, Object oriented programming	+	+	+	+	+	+	+				+	+
Scripts	+	+	+	+	+	+	+					
Semantic nets					+							
MANIPULATION OF KNOWLEDGE												
Abstraction	+	+	+	+	+	+	+					
Inheritance	+	+		+	+	+					+	
Pattern matching	+	+	+	+	+	+	+					
Augmented transition networks					+							
Chaining		+		+	+	+					+	
CONTROL STRATEGIES												
Demons/Methods	+	+	+	+	+	+	+	+	+	+	+	+
Blackboards	+	+	+	+	+	+						
UNCERTAINTY MANAGEMENT												
Fuzzy logic	+	+	+		+	+	+					
Dempster shaeffer theory		+	+			+						
Baysian inference						+						
AUTOMATIC PROGRAMMING												
Module selection and sequencing	+		+		+							
Learning capability						+						
EXPLANATION CAPABILITY	+	+	+	+	+	+	+	+	+	+	+	+
META KNOWLEDGE	+	+	+		+	+	+					
NATURAL LANGUAGE INTERFACES					+							
DESIGN CAPTURE		+				+						+

SOFTWARE SETS

A - SPECIAL OBS OPPS EXECUTIVES
B - USER REQUIREMENTS DATA BASE INTERFACE
C - EDITOR EXECUTIVES
D - RESCHEDULER
E - SYSTEM EXECUTIVES PHASE I
F - SYSTEM EXECUTIVES PHASE II
G - COMMAND PLANNER
H - NEW TIMELINE SOFTWARE
I - MODIFIED TIMELINE SOFTWARE
J - MODIFIED ORBITAL MECHANICS SOFTWARE
K - MODIFIED DATA FLOW SOFTWARE
L - OUTPUT PROCESSOR EXECUTIVE

7.6.1 Representation of Knowledge

Production Rules

Rules are useful for representation of decision trees, i.e., "if/then" statements to be accessed only when the precedent matches the real world model. This technique exists in all the large mainframe AI tools and it is the principal technique used in many PC-based tools.

Applications in the SS MPS include rules for experiment model building, software module selection and sequencing, scheduling, output formatting, logic manipulations and generic rules for processing data outside the current domain.

State Space Representations

Space state representations are useful to represent domains with a large number of input criteria and a large number of acceptable outputs. This technique is implemented in several expert systems used for route finding, chess playing, etc.

Applications in the SS MPS include rescheduling strategies,and mapping of logic solution paths in experiment integration.

Frames/Object Oriented Programming

Object oriented programming is an organization technique that divides a large "master" program into subprograms, similar to FORTRAN subroutines, called modules or objects. The data used by the module is also stored in the module. When dialog is needed between objects they send standardized messages to each other. (See Demons below under Control Strategies.) Objects can be organized in a traditional hierarchical structure but the emphasis is for module autonomy, i.e., controlling functions and decisions are made at the lowest possible level in the hierarchy. This programming technique has proven especially powerful for modeling real world objects and their interaction with other objects. Implementations have been in graphics, animation, and factory floor simulations.

Object oriented programming also facilitates frequent updates to the domain knowledge base since code is localized. This makes modeling feasible for a task that is constantly changing in definition.

Object oriented programming emphasizes the use of calls to common library routines. This results in a substantial reduction of the number of lines of source code required.

This technique has been implemented in languages like SMALLTALK-80, MODULA2, SIMULA-67, CLU, and LISP tools like ART and KEE. Object oriented programming is one of the primary goals of ADA. It can be implemented by data hiding, function hiding, common module libraries, operator overloading and other techniques.

Scripts

Scripts is a set of data patterned after real world scenarios which can be used to provide default values and predict typical responses in a real world situation. Scripts are typically stored in frames (objects) and selected using the pattern matching technique.

Applications in the SS MPS include supplying default values to incomplete user input data, supporting intelligent dialog in a natural language interface, and providing canned planning strategies for default planning by the user.

Semantic Nets

Semantic nets represent objects, actions, or events as nodes and their relationships as interconnecting links. The technique is useful for mapping multidimensional inheritance trees and viewing it from any perspective. The technique is used extensively in Natural Language Interfaces to map text into paraphrases and primitives to be processed by separate routines.

7.6.2 Manipulation of Knowledge

Abstraction

AI languages facilitate the implementation of abstraction by their ability to encode heuristics and logic functions. Abstraction techniques are used to efficiently search through a large set of detailed, possibly incomplete, data to produce sets of possible solutions. Abstraction is a technique which allows the software to create previously undefined configurations from a domain of apparently unrelated facts. In conventional programs all processing paths are predetermined by the programmer which is likely to result in an inefficient search through the possible solution space.

Applications in the SS MPS include: generalization of specific details to a higher level of requirements definition; inference of non-specific English language to specific meaning; and restricting rescheduling in the effort to locate a "best" solution.

Inheritance

Links between objects in object oriented programming allow them to obtain information from their "parent" objects (objects established as "above" them in a hierarchy structure). This significantly reduces the amount of code required at the lower element levels, and assures continuity throughout a branch of related objects.

Applications to the SS MPS include: tailoring dialog in a NLI to a particular person; passing constraints of an experiment down to the step level; filling in meaningful data where scripts don't apply or fall short; and allowing vocabulary modules to inherit meanings from a particular discipline.

Pattern Matching

AI languages have the capability to search through the knowledge base and pick a particular object based upon its content without having to know the object identifier or data type. This eliminates the need for arbitrary naming and data typing necessary in conventional languages.

Applications to SS MPS include activation of rule sets, selection of scripts, and analysis of decisions at state space nodes.

Augmented Transition Networks

When coupled with Semantic Nets this is the most popular technique used in Natural Language interfaces.

Chaining

Forward chaining (data driven search) and backward chaining (goal directed search) are the two established methods for searching through a state space. Forward chaining is typically used for design and configuration problems. Backward chaining is typically used for diagnostic problems.

Applications to the SS MPS include concept formulation, and generation of queries from the knowledge base to the user.

7.6.3 Control Strategies

Demons/Methods

Demons, or methods, are used with object oriented programming to pass messages between objects (causing the receiver to perform an action upon itself). They are programs that wait for a particular condition to occur.

Applications to the SS MPS include consistency checking input data from the real world against previous input data or known conditions, and activation of rule sets to handle queries outside of the current domain.

Blackboards

Blackboards is a technique used widely in "Sensor Fusion", allowing separate routines to post their proposed solutions in a global or restricted data area to be accessed by other routines for constraint monitoring. This technique serves as a "checks and balances" technique to verify that no routine exceeds its authority in making decisions or assumptions. This strategy of executing routines based upon the contents of the blackboard differs from the hierarchical control strategy of conventional programs in which each program has a predefined and limited set of possible activators.

Applications to the SS MPS include constraint checking between large modules of varying conditions, i.e., intermodule, interdepartment, interdiscipline, and interexperiment.

7.6.4 Uncertainty Management

Fuzzy Logic

Values needed by the system can be inferred from values provided by the user or otherwise presently known by the system. This could be useful in supplementing an incomplete data entry by the user. The technique of Fuzzy Logic can be used to perform reliable assumptions. Fuzzy Logic grades or qualifies statements rather than evaluating them to be strictly true or false. The results of Fuzzy reasoning are not as definite as those derived by strict logic, but they cover a wider range of possibilities.

Applications to the SS MPS include tracking of assumptions, and encoding qualitative rather than quantitative information about an object.

Dempster Shafer

Humans sometimes have the uncanny ability to know the "goodness" of a particular solution. The Dempster Shafer technique allows the system to arrive at an overall numeric value, representing total confidence in the final solution, by summing the confidence factors at each decision node of a State Space, Decision Tree, etc. This can not be easily implemented in conventional languages because of the difficulty in tracing the decision path.
AI programs supplement this further by their explanation capability that allows the human to view the logic path that produced the decision.
Applications to the SS MPS include the generation of confidence factors for a particular solution.

Bayesian Inference

This is a sophisticated technique that deals in probability computations. In Bayesian Inference, the overall probability that a particular assumption is true is based on a computation of the individual probabilities and the conditional probabilities of each assumption prerequisite. This technique provides more accurate confidence factors than the Dempster Shafer technique, but requires an exponentially greater number of computations.

7.6.5 Automatic Programming

Module Selection and Sequencing

The most widely demonstrated technique of Automatic Programming is module selection and sequencing. This technique selects predefined software modules for problem solution and sequences their execution. Module selection and sequencing is typically aided by heuristic rules of operation.

Learning Capability

The capability of expert systems to learn how to solve problems outside of the current domain is based on the ability of programs to create and execute their own code. This process is similar to conventional programs generating strings of text.

The process is somewhat more straightforward in LISP since, in that language, text and data are treated identically, i.e., newly created code appears identical to all other LISP code. With the use of the EVAL statement in LISP the new code can be forced to execute. Since LISP machines have runtime linking and dynamic memory management, the code can execute immediately after its creation. Conventional systems would have to go through the compile/link cycles.

In theory these processes could be used for systems that "learn" and for "automatic programming". In practice, only a few successful and limited applications have been implemented (VLSI design, image processing, animation). More definition is required in the area of programming conventions. Most early attempts have been met with some rather bizarre computational results when attempting to generate code in real time.

Applications to the SS MPS include the ability to successfully encode changing human logic patterns used in the building of a MPS schedule.

7.6.6 Explanation Capability

The ability of AI languages to form links between elements(nodes) facilitates the display of the solution path. This is difficult to implement in conventional languages without a dedicated trace routine. Explanation of which branches were taken and why help reinforce the user's confidence in the system.

In a LISP machine the explanation path is easily traced back through the memory links performed at runtime during the solution of the problem. ADA systems implement explanation via stack pointers.

Applications to the SS MPS include the ability to explain any computation/assumption to the user to build his confidence in the system output.

7.6.7 Meta Knowledge

Problem solving systems contain the complete set of knowledge for their domain. However, they cannot handle problems outside of their domain and are unaware of this inability. When the program is queried by the user, it searches its data base for a solution. Since the domain fails to produce an affirmative answer, the answer returned is "no" instead of the correct answer of "I don't know". Programming in knowledge of "what a system does not know" significantly increases the size of the software. Definition of meta-knowledge is still a research area of AI. Techniques used include "Metadata" and Data Dictionaries.

Applications to the SS MPS include the capability of any module to recognize its own limitations and request assistance from the next higher module in the hierarchy or from the human expert.

7.6.8 Natural Language Interfaces

Natural language interfaces are one of the most successful and active areas of AI technology. Several commerically available software packages have shown adequate vocabularies in bounded domains.

Applications in the SS MPS include interfacing to the individual users to allow them access to the MPS software system.

7.6.9 Design Capture

Much emphasis is given in AI technology to programming problem solutions on a higher level. Conventional programs classically encode the numeric solution to a problem, logically supported by comments to the code. If the design of the coded module must change to meet new requirements it must be done manually, based on the comments and other supporting documentation. The capability of AI languages to directly encode the logic of the problem solution allows programs to encode the requirements more directly and to be more adaptive to requirements changes.

Applications to the SS MPS include appending logic reasoning to objects representing users, experts and experiment/Space Station hardware.

7.7 METHODOLOGY FOR CANDIDATE IMPLEMENTATION

The methodology for hardware and software host selection is illustrated in Figure 7.7-1. The software sets were evaluated against the attributes described below and given a "+" if they exhibited a need for that attribute. They were given a "-" if they had no need for that attribute.

7.7.1 VAX Vs. Symbolics Architecture

Commerical Support of Hardware

Compared to conventional computer manufacturers, very few companies are involved in the sales and service of LISP machines. For overall reliability, maintainability, proven performance, and acceptance by industry, the VAX is the best alternative. In the the SS MPS, if a task is time critical, i.e., if machine downtime must be kept to a minimum, then the VAX is the preferred processor.

However, Symbolics machines are constantly improving and the market share does not appear to be diminishing. The LISP computers will not soon become a dinosaur. But, DEC will likely market a co-processor board for its VAX computers in an effort to gain their share of the LISP computer market.

Real Time Environment

VAX processors are fast enough to support real time environments. Some LISP machines are burdened with the problem of garbage collection which is very detrimental in a real time environment.

FIGURE 7.7-1

AI METHODOLOGY FOR MPS TASKS

	TASK GROUP											
	A	B	C	D	E	F	G	H	I	J	K	L
VAX vs. SYMBOLICS												
Commercial support	+	-	+	+	+	+	+	+	+	+	+	+
Real time environment	+	-	+	+	+	+	+	+	+	+	+	+
Many users	+	+	-	+	+	+	+	+	+	+	+	+
ADA LANGUAGE												
Standardization	+	+	+	+	+	+	+	+	+	+	+	+
Size of source code	+	+	+	+	+	+	+	+	+	+	+	+
Capability to implement AI techniques	+	+	+	+	+	+	+	+	+	+	+	+
LISP LANGUAGE												
Rapid prototype environment	-	+	-	+	+	+	-	-	-	-	-	-
LISP language advantages	-	+	-	+	-	+	-	-	-	-	-	-
Tools available	-	+	-	-	+	+	-	-	-	-	-	-
PROLOG LANGUAGE												
Predicate calculus	-	+	-	+	+	+	-	-	-	-	-	-
Parallel processing	-	-	-	+	+	+	-	-	-	-	-	-
RECOMMENDED METHODOLOGY												
Deliver on VAX in ADA (no AI)								+	+	+	+	+
Deliver on VAX in ADA (use AI)	+	+	+		+	+	+					
Prototype on SYMBOLICS in LISP		+		+	+	+						
Deliver on SYMBOLICS linked to VAX				+								
Implement in Spacelab MIPS	+	+		+								

SOFTWARE SETS

A - SPECIAL OBS OPPS EXECUTIVES
B - USER REQUIREMENTS DATA BASE INTERFACE
C - EDITOR EXECUTIVES
D - RESCHEDULER
E - SYSTEM EXECUTIVES PHASE I
F - SYSTEM EXECUTIVES PHASE II
G - COMMAND PLANNER
H - NEW TIMELINE SOFTWARE
I - MODIFIED TIMELINE SOFTWARE
J - MODIFIED ORBITAL MECHANICS SOFTWARE
K - MODIFIED DATA FLOW SOFTWARE
L - OUTPUT PROCESSOR EXECUTIVE

Also, LISP and PROLOG do not execute efficiently on VAX hardware. Neither does ADA execute efficiently on a LISP machine. Therefore the only two reasonable alternatives for software in a delivery environment is LISP on a LISP machine or ADA on a VAX.

Workstations or Timeshared Terminals

LISP machines are usually dedicated workstations with a higher unit cost than the multi-user environments of VAX hardware. VAX computers are the best alternative for support of more than a few users.

7.7.2 ADA Language

Standardization of Software

ADA (ANSI approved MIL-STD 1815A) has been adopted as the language to be used in all Space Station on-board system applications. Some LISP programmers feel that this requirement will be waived for LISP subroutine calls from an ADA supervisor. The official position is not yet known.

ADA also interfaces more easily with conventional code modules like FORTRAN. Wherever interfacing is required between LISP code and conventional code it is usually performed by a hardware interface between two dedicated processors.

LISP is a powerful language well suited to solving some problems; however, there are some arguments against LISP. Since LISP is a relatively young language several dialects exist. There is as yet no industry wide standard, but DARPA has selected Common LISP. Common LISP contains a small subset of the functions available in Zetalisp (used on the Symbolics mainframes). This reduced set of functions limits the power of the language and increases the amount of code the programmer must generate. Since the language is extensible, programmers could build their own library functions. But then the variations within subroutines written by different programmers is a problem during integration of the larger program. This problem seems to be solved by adoption of a standard, such as Common LISP, but the extensibility feature is then lost.

PROLOG is also a powerful language well suited to solving problems in logic. Japan has selected it as the basis for their Fifth Generation Project, a new breed of computers they hope will replace current processors. However, PROLOG is not widely used or accepted in this country.

Size Of Source Code

LISP code is roughly equivalent to the level of detail found in assembly language for ADA. This translates to more lines for a LISP programmer to generate for an equivalent function in ADA. LISP code also requires a larger dictionary of functions. Commercial tools exist for LISP which raise the level significantly, but processing speed is decreased slightly due to the increased software overhead. Language flexibility is also decreased slightly by the rigid structure of the tool.

7.7.3 LISP Language

7.7.3.1 Rapid Prototyping Environment

Less Time In Edit/Compile/Link/Debug Cycle

In conventional hardware file manipulation must be performed between each cycle. On a LISP machine these utilities are all available under the same monitor, so transfer from one cycle to the next is instantaneous.

User Friendly Editor

Many features are easy to implement on LISP machine editors. These include windows, graphics and syntax check and correction.

Dynamic Linking

LISP elements may be manipulated independent of the values of those elements. Declaration of their value is only required just prior to output of the final solution. In conventional programs all variables must have a declared value. No such limitation exists for a LISP machine which performs dynamic linking at runtime.

Interpreters and Compilers

Incremental compilers (interpreters) are efficient, by industry opinion, on LISP machines. Interpreters are also available for conventional hardware, but are very slow and inefficient. LISP interpreters facilitate debugging during compile.

LISP machines also support traditional compilation of source code files. Benchmark tests indicate that compiling increases execution speed by 4 to 30 times and reduces source code size up to 1/3 to 1/10 of original.

Incremental Execution

This utility allows programmers to debug with the editor as errors are encountered during execution and then continue execution.

Incomplete Input Data

LISP listener environments allow programmers to execute programs and have partial solutions returned which contain the undefined data. Conventional programs will not execute without complete input data.

Dynamic Memory Management

Since memory allocations are performed at run time in LISP machines the programmer does not have to declare these as in conventional languages.

Supports Bottom-Up or Top-Down Design

LISP subroutines can be executed and will return a value. Conventional subroutines require overhead software to call the subroutine. This means software modules can be developed and tested at any time, even if the modules above it in the hierarchy are not yet implemented.

LISP will also support top down design in the same manner as conventional languages.

7.7.3.2 LISP Language Advantages

Function Library

12,000 functions currently exist in Zetalisp, enough for nearly every application by today's standards. In addition, LISP is extensible by the programmer. Extensibility allows the user to add new functions to the existing library without having to change the compiler.

Encode Heuristics

LISP lists and elements easily encompass numbers and variables used by conventional programs such as FORTRAN. Therefore, LISP can represent a wider variety of data types. The ability to encode heuristics is possible in ADA but is slightly more straightforward in LISP.

Ability To Implement Recursive Solutions

LISP functions can call themselves without limit. This is difficult to implement in ADA or any conventional languages. This technique has been implemented to represent infinite series mathematical equations, language syntax, and multidimensional organizational trees.

7.7.3.3 Tools Available

LISP tools such as ART, KEE and Knowledge Craft allow the user to code a large task with a limited knowledge of LISP. User interfaces are extremely friendly and interactive. Tools do tend to be a large overhead which uses up memory and slows processing time. But, all three vendors offer production model shells with a reduced amount of code overhead. Some projects like PLAN-IT were forced to code their own inference engine to get the needed execution speed.

7.7.4 PROLOG Language

Predicate Calculus

Predicate calculus is the most widely accepted mathematical language for modeling of logic based problems and theorems. Many of the problems in the field of AI are heavily logic based, so predicate calculus is the natural choice. LISP and ADA can implement predicate calculus equations but implementation is more straightforward in PROLOG.

Parallel Processing

Parallel Processing has been proposed as one possible solution to speed up large complex software programs. However, the serial method of solution in conventional software does not lend itself easily to division into parallel tasks. PROLOG is exceptionally well suited to this division by allocation of each decision node to a processor. The processor could be dedicated, for a massive computer by today's standards, or allocated from a common pool of available processors. The precedent matching technique of rule firings in a production system could also be divided into parallel tasks.

To date, no practical large scale systems have yet been implemented due to hardware limitations. Current efforts of Japan's Fifth Generation Computer project are focused in the field of building such processors. Techniques for programming in PROLOG also need to be refined to reduce the combinatorial explosion problem in the solution search space.

7.8 RESULTS OF EVALUATION

The evaluation of each SS MPS task against the Desired Attributes criteria produced a list of benefits and concerns for the implementation of each software set. These benefits and concerns are summarized in subsection 7.8.1.

The summation and weighing of all evaluations performed previously, resulted in the task methodology recommended for implementation. This recommendation is shown on the bottom half of Figure 7.7-1 and summarized in subsection 7.8.2.

7.8.1 Benefits/Concerns

Each software set is listed below accompanied by its:

Benefits - Those characteristics which will result in the biggest payoff after the task is automated.

Concerns - Those possible pitfalls that must be avoided during project development and implementation.

Set A - Special Obs Opps Executives

Benefits- Since expertise is scarce and it is expensive to train an expert, automation and replication of this task will result in a big payoff. Most functions are easily implemented which will result in a low initial cost and high user acceptance of output data.

Concerns- There may be a minor difficulty in defining a method for modeling a new user defined target currently outside of the knowledge base.

Set B - User Requirements Data Base Interface

Benefits- Since expertise is scarce and it is expensive to train an expert, automation and replication of this task will result in a big payoff.

Concerns- Problems may be encountered in correctly modeling the experiment as described by the user. Definition of the information extraction technique may be difficult. The user may become easily frustrated if the system fails to dialog intelligently with him. The cost of software requirements definition will be high due to the prototyping phase and the cost of a LISP tool. There is no "generic" or "worst case" acceptance test available so acceptance tests will have to be numerous.

Set C - Editor Executives

Benefits - Automation would significantly speed up this process in all cycles of planning and save significant manpower.

Concerns- None.

Set D - Rescheduler

Benefits - Since expertise is scarce and it is expensive to train an expert, automation of this task will result in a big payoff. Replication of this task will also result in a big payoff since it is needed at seven points in the MPS phases of planning. Interfaces are readily defined since they are all in electronic format. If the software is used only on the ground (planning centers and the Payload Operations Integration Center), and since the task boundary is well defined, it could be executed on a specialized LISP processor and interfaced to the VAX.

Concerns - Several methods currently exist for rescheduling. Deciding on one strategy or set of strategies could be difficult. Experience has shown on several systems that the LISP inference engine must be coded from scratch to obtain acceptable operating speed. This increases the level of effort in prototyping. However, several organizations have already developed working prototypes to address this problem.

Set E - System Executives Phase I

Benefits - Since expertise is scarce and it is expensive to train an expert, automation and replication of this task will result in a big payoff. A Natural Language Interface (NLI) would be a powerful interface tool. Several off-the-shelf commercial tools already exist.

Concerns - Defining and debugging the specialized vocabulary for the NLI will require a large manhour effort. The experts allocated to the task may not be motivated to debug the user interface down to the level of refinement necessary for the user to accept and use the NLI. Since there is no "generic" or "worst case" test for the NLI, acceptance will have to consist of an extensive battery of tests. Several successful NLI's have been developed, but they should still be considered a moderate schedule risk.

Set F - System Executives Phase II

Benefits - Implementation of the Apprentice/Advisor would result in a tremendous manpower savings over the life of the Space Station. It would be the primary step needed for future transfer of the bulk of mission planning to on-board the station.

Concerns - The highly unstable and broad domain may be difficult to model completely and accurately. The expert may be difficult to isolate and motivate to invest the time needed to train the Apprentice. System acceptance tests will have to be extensive and confidence factors tested for Planning Center and Payload Integration Center management to accept the Advisor output.

Set G - Command Planner

Benefits - Information in the SS MPS such as canned typical command timelines may be very useful to the novice user. They impose no restriction on the experienced PI.

Concerns - Since expertise is a plentiful resource for each dedicated PI and the time required to create a command timeline is relatively short, the cost of encoding intelligent software to assist the user may not be cost effective.

Set H - New Timeline Software

Benefits - Tasks to be implemented are straightforward and do not require a large use of AI techniques.

Concerns- none.

Set I - Modified Timeline Software

Benefits - Tasks to be implemented are straightforward and do not require a large use of AI techniques.

Concerns - none.

Set J - Modified Orbital Mechanics Software

Benefits - Tasks to be implemented are straightforward and do not require a large use of AI techniques.

Concerns - none.

Set K - Modified Data Flow Software

Benefits - This task could be more flexible to a changing Space Station configuration environment by using Object Oriented Programming to model the individual hardware elements and the constraints and interactions between the elements and the station.

Concerns - The major portion of the task is already coded (SSDFAST in FORTRAN), therefore recoding into ADA would not be cost effective.

Set L - Output Processor Executive

Benefits - This task could be more flexible to a changing Space Station configuration environment by using Object Oriented Programming and Design Capture to model the requirements for printing/display formats and the constraints on each module of information.

Concerns - The major portion of the task is already coded (PCAP and PTS in FORTRAN), therefore recoding into ADA would not be cost effective.

7.8.2 Methodology Summary

Fourteen tasks were selected as candidates for using AI techniques. Thirteen tasks are recommended to be delivered in ADA on the VAX.

One task is recommended to be delivered on the Symbolics in LISP with a hardware interface to the VAX. At a future date it should be ported to the VAX prior to installation on-board the Space Station.

Four tasks are recommended for prototyping on the Symbolics Machine.

Three tasks are recommended for implementation in the Spacelab MIPS.

7.9 CONCLUSIONS AND RECOMMENDATIONS

7.9.1 AI Technology

AI technology is still very young. The experience base of expert systems performance is small compared to conventional programs. However, the systems in existence do strongly support the many advantages of incorporating this technology into the workplace. AI has proven effective in solving many of the problems where conventional programs fail.

7.9.2 Hardware/Software Architecture

The conclusion to largely use ADA on a VAX is also supported by a study conducted by MDAC-HB for the JSC Space Station Phase B contract.

The largest value of LISP and PROLOG is in the rapid prototyping environment.

7.9.3 Software Tools

Use is recommended during prototyping of an expert system development tool and a natural language development tool.

An in-depth technology survey, with the targeted MPS candidates in mind, should be performed immediately prior to purchase of any off-the-shelf AI tools.

Section 8

TASK 5 - SOFTWARE DEVELOPMENT PLAN

The objective of this task was to generate a Software (SW) Development Plan for the definition, design and implementation of the SS MPS.

The approach taken to this task consisted of four subtasks. First, assumptions inherent in the generation of the SW Development Plan were identified; these pertained to SW development facilities, computer operating systems, coding languages and standards, required formal reviews, required documentation, etc. The second subtask involved developing a technical description of the project - SW requirements, SW hierarchy, etc., and a detailed description of the activities required to successfully complete the development project. Based on the assumptions of subtask 1 and the descriptions of subtask 2, subtask 3 was performed to generate cost estimates for individual or sets of required SS MPS computer programs in terms of manpower and schedule using the Constructive Cost Model (COCOMO), and integrating these into project level manpower requirements and schedule recommendations. The fourth and final subtask was to document and publish the SW Development Plan.

Inputs to this study task were derived from:

- Task 3 products (SS MPS Functional Flows and SW Requirements Summary)
- Task 4 products (AI recommendations and implementation requirements)
- COCOMO Model
- Existing SW development plans (boilerplates)

The product of this task is the SS MPS SW Development Plan, which constitutes Volume III of the Study final report. In summary, the SW Development Plan documents requirements for a 4841 manmonth effort over a 64 month period to successfully complete the SS MPS software development project.

Section 9

CONCLUSIONS AND RECOMMENDATIONS

Based on the results of the SS MPS Development Study presented in the previous section, the following conclusions have been drawn:

1) A detailed definition of the Spacelab payload mission planning process and SL MIPS software has been derived; this definition (functional flow diagrams and data base) will be of great value for training Spacelab mission planning personnel and for assessing and improving the process.

2) A baseline concept for performing SS manned base payload mission planning has been developed; this concept is consistent with current Space Station design/operations concepts and philosophies; however, those concepts and philosophies are the results of Phase B studies and will therefore gain further definition and changes as the Space Station Program progresses.

3) SS MPS software requirements have been defined. These software requirements make maximum use of SL MIPS software with modifications, but do include requirements for new software to accommodate the complexity of the SS mission planning concept and to maximize automation of the concept. Also, requirements for new software include candidate programs for the application of AI techniques to capture and make more effective use of mission planning expertise and to involve SS users directly in the mission planning process.

4) A SS MPS Software Development Plan has been developed which phases efforts for the development of software to implement the SS mission planning concept. The efforts are phased for the immediate start of development of long-lead-time software programs, but for delayed development of programs with a high dependence on SS design/operations concepts. The development schedule, relative to the current overall Space Station Program schedule, indicates the development effort should begin as soon as possible.

5) The estimated manpower requirements to develop the SS MPS are significant; however, the scope of the SS mission planning problem is significant and the process of development is recommended to be highly structured and rigidly controlled. Nonetheless, the software system concept is intended to provide uniform methods of planning payload operations across all equivalent planning levels in order to facilitate the integration of planning, and is intended to maximize the automation of mission planning to minimize long-term mission planning costs.

Based on the conclusions above, the following recommendations are offered:

1) Use the definition (functional flows and data base) of the Spacelab payload mission planning process and software to train mission planning personnel and to evaluate and improve the process. As improvements are made, update the flow diagrams and data base.

2) Proceed with implementation of the SS MPS Software Development Plan, including the structured and controlled process for software development.

3) Maintain the SS mission planning concept, software system concept, and Software Development Plan consistent with SS design/operations concepts and program schedules.

4) Use Spacelab mission planning as a test bed for testing prototypes of AI applications.

APPENDIX A

SPACELAB MIPS DATA BASE

The SL MIPS data base was developed in order to provide activity summary data, software description and requirements data, and activity time and skill requirements data. The level of detail of the data base is consistent with the level of detail in the Spacelab mission planning process detailed flow diagrams; that is, entries exist in the data base corresponding to each lowest hierarchical level activity (function, subfunction, task or subtask) identified for every function in the flow diagrams. When assessed in conjunction with the detailed flows, the data base provides a comprehensive definition of the Spacelab payload mission planning process.

The data base consists of eight (8) interrelated tables of data:

- Activity Summary Data
- Activity Time and Skill Requirements
- Software Used by Activity
- Software Description
- Software Peripherals Required
- Activity Input/Outputs
- Computer Input/Output Summary
- Manual Input/Output Summary

Table 1 provides the activity summary data which identifies an activity and its position in the hierarchy of activities (function, subfunction, task, subtask), the activity objective, method of accomplishment (manual or automatic), and the need for the activity.

Table 2 provides the activity time and skill requirements data which includes, for each activity, skill type and skill level, manpower requirements and throughput calendar time for each cycle the activity is performed. Time here refers to the total amount of time required to accomplish the activity (data collection and assessment, analysis, computer setup time required, and evaluation of results). The mission planning cycles are, in sequence, preliminary (P), basic (B), update (U), and replanning (R).

Table 3 provides the software identification for activities that are automated, and the required computer setup time for each cycle the activity is performed. Time here is inclusive of time required for file updates/edits, runstream development, and software interaction.

Table 4 provides a description and the resource requirements for each software module. This table is linked to other tables in the data base by software name. Data included are: software function definition, mode of operation, skill requirements, language, lines of code, memory requirements, and estimated CPU time. In this table, where a software name is followed by a number (NAME-1), the number links the software to a particular activity in other tables. A software module may be used to accomplish several different activities; the difference in this table is the required CPU time.

Table 5 identifies the interface peripheral required by a user to exercise a particular software module.

Table 6 provides an input/output summary for all the activities performed during the mission planning process. For each activity the following data is provided: input/output name, I/O form (computer or manual), software module association, the I/O type (input or output), source or destination of I/O, and an indication of which planning cycles utilize the I/O.

Table 7 provides summary data for all computer input/outputs. Data included are: input/output name, file size (maximum, minimum) and a brief description of the data contained in the input/output file. For some input/outputs only one entry is made for file size (minimum). These values are provided as an average (typical) file size.

Table 8 provides summary data for all manual input/outputs. Data included are: input/output name, type (form) of input/output (verbal, written, formal or informal document), name of document (if applicable) in which the input/output is published, and a brief description of the data contained in the input/output.

TABLE 1
ACTIVITY SUMMARY DATA

```
                                        ACTIVITY SUMMARY DATA                                        DATE 04/08/87

                                                                                                     PAGE         1

FUNCTION     SUBFUNCTION  TASK         SUBTASK               ACTIVITY OBJECTIVE                    METHOD       NEED
------------ ------------ ------------ --------------------  ------------------------------------  -----------  ----------
PAYLOAD DATA PAYLOAD DATA PAYLOAD DATA PAYLOAD DATA          ONCE THE PAYLOAD COMPLEMENT HAS BEEN  MANUAL       ROUTINE
COLLECTION   COLLECTION   COLLECTION   COLLECTION            SELECTED AND DEFINED, PAYLOAD DATA IS
                                                             COLLECTED AND PROCESSED AS NECESSARY
                                                             TO PERFORM REQUIRED MISSION PLANNING
                                                             ANALYSIS.  SOURCES OF DATA INCLUDE
                                                             PAYLOAD COMPLEMENT DEFINITION, ERD'S
                                                             AND PI INTERFACE.  AFTER PAYLOAD DATA
                                                             HAS BEEN COLLECTED AND EVALUATED
                                                             INPUTS/UPDATES ARE MADE TO THE IPRD
                                                             AND O&IA.

ORBITAL      ORBIT        ORBIT        ORBIT REQUIREMENTS    SELECT A MISSION ORBIT WHICH BEST     MANUAL/AUTOM ROUTINE
ANALYSIS     REQUIREMENTS REQUIREMENTS EVALUATION AND        MEETS SCIENCE OBJECTIVES AND SYSTEMS  ATIC
             EVALUATION   EVALUATION   SELECTION             REQUIREMENTS.  THE TASK INVOLVES
             AND          AND                                SELECTION OF AN ORBIT ALTITUDE AND
             SELECTION    SELECTION                          INCLINATION WHICH MEETS
                                                             REQUIREMENTS/CONSTRAINTS WHILE
                                                             SATISFYING PHASING REQUIREMENTS, IF
                                                             ANY.  THIS IS NORMALLY A MANUAL TASK,
                                                             HOWEVER IF A TRADES ANALYSIS IS
                                                             REQUIRED SOME SOFTWARE MAY BE USED.
                                                             THE SUBTASKS AND SOFTWARE MODULES
                                                             USED FOR TRADES ANALYSIS ARE
                                                             PERFORMED ELSEWHERE IN THE MISSION
                                                             PLANNING PROCESS.

ORBITAL      LAUNCH       LAUNCH       LAUNCH WINDOW/LAUNCH  DETERMINE THE AVAILABLE LAUNCH WINDOW AUTOMATIC/MA ROUTINE
ANALYSIS     WINDOW/LAUNC WINDOW/LAUNC TIME SELECTION        BASED ON PAYLOAD/EXPERIMENT AND STS   NUAL
             H TIME       H TIME                             CONSTRAINTS, AND PICK LAUNCH TIME
             SELECTION    SELECTION                          THAT MAXIMIMIZES LAUNCH WINDOW

---------------------------------------------------------------------------------------------------------------------------
```

FUNCTION	SUBFUNCTION	TASK	SUBTASK	ACTIVITY OBJECTIVE	METHOD	NEED
ORBITAL ANALYSIS	STATE VECTOR GENERATION/EPHEMERIS DATA DEVELOPMENT	GENERATE STATE VECTOR	GENERATE STATE VECTOR	PROJECT A STATE VECTOR AT THE TIME OF INSERTION.	AUTOMATIC	ROUTINE
ORBITAL ANALYSIS	STATE VECTOR GENERATION/EPHEMERIS DATA DEVELOPMENT	CONVERT/STORE STATE VECTOR	CONVERT/STORE STATE VECTOR	TAKE AS INPUT A LAUNCH DATE AND TIME, AND A STATE VECTOR AS ACQUIRED FROM JSC (IN ENGLISH UNIT), CONVERT TO APPROPRIATE FORM AND UNITS, AND STORE IN CASE STORAGE FILES FOR USE BY ASEP, NSEP, AND/OR TANRAY.	AUTOMATIC	ROUTINE
ORBITAL ANALYSIS	STATE VECTOR GENERATION/EPHEMERIS DATA DEVELOPMENT	GENERATE ORBITAL EPHEMERIS BY NUMERICAL INTEGRATION	GENERATE ORBITAL EPHEMERIS BY NUMERICAL INTEGRATION	GENERATE ORBITAL ENPHEMERIS DATA BY NUMERICAL INTEGRATION OF THE EQUATIONS OF MOTION. THIS TASK CONSIDERS ATMOSPHERIC DRAG FOR MISSIONS (LOW ORBITS) WHERE DRAG IS A FACTOR IN CALCULATING THE EPHEMERIS DATA.	AUTOMATIC	IF DRAG IS A FACTOR
ORBITAL ANALYSIS	STATE VECTOR GENERATION/EPHEMERIS DATA DEVELOPMENT	GENERATE REQUIRED EPHEMERIS DATA FOR OUTPUT	GENERATE REQUIRED EPHEMERIS DATA FOR OUTPUT	GENERATE REQUIRED EPHEMERIS DATA FOR SUBSEQUENT ANALYSIS.	AUTOMATIC	ROUTINE
ORBITAL ANALYSIS	EXPERIMENT OPPORTUNITIES GENERATION	GENERATE MISSION INDEPENDENT TARGETS	GENERATE EARTH SHADOW ACQ/LOSS	DETERMINE THE TIMES WHEN THE ORBITER ENTERS AND LEAVES THE EARTH'S SHADOW.	AUTOMATIC	ROUTINE

FUNCTION	SUBFUNCTION	TASK	SUBTASK	ACTIVITY OBJECTIVE	METHOD	NEED
ORBITAL ANALYSIS	EXPERIMENT OPPORTUNITIES GENERATION	GENERATE MISSION INDEPENDENT TARGETS	GENERATE SUN RISE/SET	DETERMINE THE TIMES WHEN THE ORBITER ENTERS AND LEAVES SUNLIGHT. THIS IS DONE BY TAKING THE COMPLEMENT OF THE EARTH SHADOW ACQ/LOSS TIMES.	AUTOMATIC	ROUTINE
ORBITAL ANALYSIS	EXPERIMENT OPPORTUNITIES GENERATION	GENERATE MISSION INDEPENDENT TARGETS	GENERATE MOON RISE/SET	COMPUTE THE ACQUISITION AND LOSS TIMES OF THE MOON AS SEEN BY THE ORBITER IN ORBIT.	AUTONTIC	ROUTINE
ORBITAL ANALYSIS	EXPERIMENT OPPORTUNITIES GENERATION	GENERATE MISSION INDEPENDENT TARGETS	GENERATE PRELIMINARY TDRS COVERAGE	GENERATE PRELIMINARY TDRS COVERAGE BASED ON BEST ESTIMATE (PRELIMINARY) ATTITUDE TIMELINE.	AUTOMATIC	ROUTINE
ORBITAL ANALYSIS	EXPERIMENT OPPORTUNITIES GENERATION	GENERATE MISSION INDEPENDENT TARGETS	GENERATE GROUND STATION COVERAGE	DETERMINE THE TIMES THAT THE ORBITER IS IN COMMUNICATION WITH GROUND TRACKING STATIONS.	AUTOMATIC	ROUTINE
ORBITAL ANALYSIS	EXPERIMENT OPPORTUNITIES GENERATION	GENERATE MISSION INDEPENDENT TARGETS	GENERATE RADIATION ENVIRONMENT	DETERMINE THE FLUX OF CHARGED PARTICLES (PROTONS, ELECTRONS AT SOLAR MAXIMUM AND ELECTRONS AT SOLAR MINIMUM) GIVEN A SET OF POINTS (ALTITUDE, LATITUDE, LONGITUDE) IN SPACE AND AN ENERGY THRESHOLD.	AUTOMATIC	ROUTINE
ORBITAL ANALYSIS	EXPERIMENT OPPORTUNITIES GENERATION	GENERATE MISSION INDEPENDENT TARGETS	IMPOSE RADIATION CONSTRAINTS	DETERMINE OPERATING PERIODS BASED ON ACCEPTABLE RADIATION LEVELS/CONDITIONS.	AUTOMATIC	ROUTINE

FUNCTION	SUBFUNCTION	TASK	SUBTASK	ACTIVITY OBJECTIVE	METHOD	NEED
ORBITAL ANALYSIS	EXPERIMENT OPPORTUNITIES GENERATION	GENERATE MISSION INDEPENDENT TARGETS	MERGE MISSION INDEPENDENT TARGETS	MERGE MISSION INDEPENDENT TARGETS INTO ONE COMMON FILE. THESE TARGETS INCLUDE SUN RISE/SET TIMES, MOON RISE/SET TIMES, PRELIMINARY TDRS COVERAGE, GROUND STATION COVERAGE, AND SOUTH ATLANTIC ANOMALY RADIATION CONSTRAINT TIMES (SAA).	AUTOMATIC	ROUTINE
ORBITAL ANALYSIS	EXPERIMENT OPPORTUNITIES GENERATION	GENERATE CELESTIAL TARGETS	DEVELOP CELESTIAL TARGETS (NON-IPS MISSIONS)	DEVELOP THE CELESTIAL TARGET FILE. THE TARGET FILE IS MANUALLY DEVELOPED USING THE STAR PROGRAM.	MANUAL	ROUTINE
ORBITAL ANALYSIS	EXPERIMENT OPPORTUNITIES GENERATION	GENERATE CELESTIAL TARGETS	DEVELOP CELESTIAL TARGETS (IPS MISSIONS)	DEVELOP THE CELESTIAL TARGET FILE. THIS IS DONE USING THE SUBCOO PROGRAM TO DEVELOP A SUBSET OF THE PI COOBSERVATION FILE.	AUTOMATIC	IPS MISSION
ORBITAL ANALYSIS	EXPERIMENT OPPORTUNITIES GENERATION	GENERATE CELESTIAL TARGETS	GENERATE CELESTIAL TARGET(S) ACQ/LOSS	DETERMINE THE ACQUISITION AND LOSS TIMES FOR THE CANDIDATE TARGETS.	AUTOMATIC	ROUTINE
ORBITAL ANALYSIS	EXPERIMENT OPPORTUNITIES GENERATION	GENERATE CELESTIAL TARGETS	COMBINE CONSTRAINTS TO DETERMINE CELESTIAL TARGETS AND MERGE FILES	DETERMINE VIEWING PERIODS BASED ON STELLAR OBSERVATION REQUIREMENTS/CONSTRAINTS AND MERGE RESULTANT FILES INTO ONE COMMON FILE.	AUTOMATIC	ROUTINE
ORBITAL ANALYSIS	EXPERIMENT OPPORTUNITIES GENERATION	GENERATE ATMOSPHERIC PHYSICS TARGETS	COMPUTE DISTANCE FROM TANGENT POINT ON THE ORBITER TO SUN LINE-OF-SIGHT TO THE EARTH SURFACE	DETERMINE OPPORTUNITIES TO VIEW THE SUN THROUGH CERTAIN LAYERS OF THE ATMOSPHERE.	AUTOMATIC	ROUTINE

FUNCTION	SUBFUNCTION	TASK	SUBTASK	ACTIVITY OBJECTIVE	METHOD	NEED
ORBITAL ANALYSIS	EXPERIMENT OPPORTUNITIES GENERATION	GENERATE ATMOSPHERIC PHYSICS TARGETS	DEVELOP/APPLY CONSTRAINTS TO ATMOSPHERIC PHYSICS OBSERVATION PERIODS	DEVELOP ATMOSPHERIC PHYSICS OBSERVATION PERIODS WITHIN ACCEPTABLE CONDITIONS.	AUTOMATIC	ROUTINE
ORBITAL ANALYSIS	EXPERIMENT OPPORTUNITIES GENERATION	GENERATE ATMOSPHERIC PHYSICS TARGETS	COMPUTE ORBIT TERMINATOR TARGETS	DETERMINE TARGETS AT, OR NEAR, THE TERMINATOR.	AUTOMATIC	ROUTINE
ORBITAL ANALYSIS	EXPERIMENT OPPORTUNITIES GENERATION	GENERATE ATMOSPHERIC PHYSICS TARGETS	COMBINE CONSTRAINTS TO DETERMINE ATMOSPHERIC PHYSICS TARGETS	DETERMINE OPERATING PERIODS BASED ON ATMOSPHERIC PHYSICS REQUIREMENTS/CONSTRAINTS.	AUTOMATIC	ROUTINE
ORBITAL ANALYSIS	EXPERIMENT OPPORTUNITIES GENERATION	GENERATE ATMOSPHERIC PHYSICS TARGETS	COMPUTE SUN AZIMUTH AND ELEVATION FROM ORBITING VEHICLE WITH RESPECT TO SUN RISE/SET EVENTS	DETERMINE THE SUN AZIMUTH AND ELEVATION AS SEEN FROM AN ORBITING VEHICLE WITH RESPECT TO THE SUN RISE/SET EVENTS.	AUTOMATIC	REALTIME FUNCTION
ORBITAL ANALYSIS	EXPERIMENT OPPORTUNITIES GENERATION	GENERATE SOLAR TARGETS	DEVELOP CONSTRAINTS FOR SOLAR VIEWING PERIODS	DEVELOP SOLAR VIEWING PERIODS WITHIN ACCEPTABLE CONDITIONS.	AUTOMATIC	IPS MISSION
ORBITAL ANALYSIS	EXPERIMENT OPPORTUNITIES GENERATION	GENERATE SOLAR TARGETS	COMBINE CONSTRAINTS TO DETERMINE SOLAR TARGETS	DETERMINE VIEWING PERIODS BASED ON SOLAR REQUIREMENTS/CONSTRAINTS.	AUTOMATIC	IPS MISSION
ORBITAL ANALYSIS	EXPERIMENT OPPORTUNITIES GENERATION	GENERATE EARTH OBSERVATION TARGETS	CREATE EARTH SITE DEFINITION FILE	DEFINE POLYGONAL AREAS OF CANDIDATE GROUND TARGET SITES.	AUTOMATIC	ROUTINE

FUNCTION	SUBFUNCTION	TASK	SUBTASK	ACTIVITY OBJECTIVE	METHOD	NEED
ORBITAL ANALYSIS	EXPERIMENT OPPORTUNITIES GENERATION	GENERATE EARTH OBSERVATION TARGETS	GENERATE ACQ/LOSS OF GROUND SITE TARGET AREAS	GENERATE ACQUISITION AND LOSS TIMES OF THE DEFINED EARTH TARGET AREAS.	AUTOMATIC	ROUTINE
ORBITAL ANALYSIS	EXPERIMENT OPPORTUNITIES GENERATION	GENERATE EARTH OBSERVATION TARGETS	DEVELOP/APPLY CONSTRAINTS TO EARTH OBSERVATION TARGETS	DEVELOP EARTH OBSERVATION PERIODS WITHIN ACCEPTABLE CONDITIONS.	AUTOMATIC	ROUTINE
ORBITAL ANALYSIS	EXPERIMENT OPPORTUNITIES GENERATION	GENERATE EARTH OBSERVATION TARGETS	COMBINE CONSTRAINTS TO DETERMINE EARTH OBSERVATION TARGETS	DETERMINE OPERATING PERIODS BASED ON EARTH OBSERVATION REQUIREMENTS/CONSTRAINTS.	AUTOMATIC	ROUTINE
ORBITAL ANALYSIS	EXPERIMENT OPPORTUNITIES GENERATION	GENERATE PLASMA PHYSICS TARGETS	COMPUTE ORIENTATION AND STRENGTH OF MAGNETIC FIELD IN THE ORBITER COORDINATE SYSTEM	COMPUTE THE ORIENTATION AND STRENGTH OF THE MAGNETIC FIELD RELATIVE TO THE ORBITER POSITION.	AUTOMATIC	ROUTINE
ORBITAL ANALYSIS	EXPERIMENT OPPORTUNITIES GENERATION	GENERATE PLASMA PHYSICS TARGETS	DEVELOP/APPLY CONSTRAINTS TO BORB PARAMETERS	DEVELOP PLASMA PHYSICS OBSERVATION PERIODS WITHIN ACCEPTABLE CONDITIONS.	AUTOMATIC	ROUTINE
ORBITAL ANALYSIS	EXPERIMENT OPPORTUNITIES GENERATION	GENERATE PLASMA PHYSICS TARGETS	GENERATE HEMISPHERE OPPORTUNITIES	DEVELOP HEMISPHERE OPPORTUNITIES BASED ON LATITUDE CONSTRAINTS.	AUTOMATIC	ROUTINE
ORBITAL ANALYSIS	EXPERIMENT OPPORTUNITIES GENERATION	GENERATE PLASMA PHYSICS TARGETS	COMBINE CONSTRAINTS TO DETERMINE PLASMA PHYSICS TARGETS	DETERMINE OPERATING PERIODS BASED ON PLASMA PHYSICS REQUIREMENTS/CONSTRAINTS.	AUTOMATIC	ROUTINE

FUNCTION	SUBFUNCTION	TASK	SUBTASK	ACTIVITY OBJECTIVE	METHOD	NEED
ORBITAL ANALYSIS	EXPERIMENT OPPORTUNITIES GENERATION	MERGE ALL EXPERIMENT TARGET FILES	MERGE ALL EXPERIMENT TARGET FILES	MERGE ALL EXPERIMENT TARGET FILES (OPPORTUNITIES) INTO ONE COMMON FILE. THESE TARGET FILES (OUTPUTS) ARE THE RESULT OF ORBITAL ANALYSIS FOR DIFFERENT SCIENCE DIDCIPLINES.	AUTOMATIC	ROUTINE
ORBITAL ANALYSIS	EXPERIMENT OPPORTUNITIES GENERATION	GENERATE MATERIAL AND/OR LIFE SCIENCE TARGETS	GENERATE MATERIAL AND/OR LIFE SCIENCE TARGETS	NOTE: MATERIAL/LIFE SCIENCE TARGET PERIODS ARE DEVELOPED/ASSIGNED BASED ON EXPERIMENT OPERATIONS AND SYSTEMS REQUIREMENTS IN THE "MISSION PROFILE GENERATION" SUBFUNCTION. THE PURPOSE OF THIS TASK IS TO SHOW THAT MATERIAL AND LIFE SCIENCE EXPERIMENTS ARE COMMON TO THE SPACELAB MISSION PLANNING SYSTEM. THESE SCIENCE DISCIPLINES ARE NOT DEPENDENT ON ORBIT GEOMETRY, BUT RATHER MORE SO ON LOW-GRAVITY ATTITUDES, AND TDRS COVERAGE.	N/A	N/A
ORBITAL ANALYSIS	EXPERIMENT OPPORTUNITIES GENERATION	GENERATE CO-ORBITING TARGETS	PERFORM PARAMETRIC ANALYSIS TO DESIGN/DEVELOP CO-ORBITING TRAJECTORIES THAT SATISFY OBJECTIVES AND CONSTRAINTS	PERFORM A PARAMETRIC ANALYSIS CONSIDERING THE BASIC CO-ORBITING REQUIREMENTS (SUCH AS DEPLOYMENT, PROXIMITY OPS, GRAPPLE/CAPTURE) AS WELL AS THE PI REQUIREMENTS/CONSTRAINTS AND STS REQUIREMENTS/CONSTRAINTS.	AUTOMATIC/MANUAL	ROUTINE
ORBITAL ANALYSIS	MISSION PROFILE GENERATION	DEVELOP GROSS MISSION TIMELINE	DEVELOP GROSS MISSION TIMELINE	DEVELOP A GROSS MISSION TIMELINE BY EVALUATING EXPERIMENT OPPPORTUNITIES AND TAKING INTO CONSIDERATION MISSION PRIORITIES, DIFFICULTY OF EXPERIMENT SCHEDULING, CREW ACTIVITIES, SYSTEMS REQUIREMENTS,AND MANAGEMENT DIRECTION.	MANUAL	ROUTINE

FUNCTION	SUBFUNCTION	TASK	SUBTASK	ACTIVITY OBJECTIVE	METHOD	NEED
ORBITAL ANALYSIS	MISSION PROFILE GENERATION	DEVELOP PRELIMINARY ATTITUDE TIMELINE	DEVELOP PRELIMINARY ATTITUDE TIMELINE	DEVELOP A PRELIMINARY ATTITUDE TIMELINE BASED ON THE ATTITUDE REQUIREMENTS FROM THE "AGREED TO" GROSS MISSION TIMELINE.	AUTOMATIC	ROUTINE
ORBITAL ANALYSIS	DEDICATED STELLAR OBSERVATION GENERTION	CREATE COMMON FILE FOR ASTAR PROGRAM (DS)	CREATE COMMON FILE FOR ASTAR PROGRAM (DS)	READ TARGET AND TARGET DEFINITION FILES AND REFORMAT/EDIT THIS DATA INTO A NEW FORMAT WHICH THE ASTAR PROGRAM WILL ACCEPT.	AUTOMATIC	DEDICATED STELLAR MISSION
ORBITAL ANALYSIS	DEDICATED STELLAR OBSERVATION GENERATION	CREATE RESERVE PERIOD FILE (DS)	CREATE RESERVE PERIOD FILE (DS)	CREATE A FILE CONTAINING RESERVED PERIODS FOR TARGETS THAT ARE DIFFICULT TO VIEW, CREW ACTIVITY, SYSTEM REQUIREMENTS, MOVING TARGETS, ETC.	MANUAL	DEDICATED STELLAR MISSION
ORBITAL ANALYSIS	DEDICATED STELLAR OBSERVATION GENERATION	SCHEDULE SCIENCE OBSERVATIONS (DS)	SCHEDULE SCIENCE OBSERVATIONS (DS)	GENERATE VIEWING SCHEDULE FOR DEDICATED ASTRONOMY MISSIONS. GENERATE THIS SCHEDULE MAKING EFFICIENT USE OF AVAILABLE OBSERVATION TIME WHILE MINIMIZING VEHICLE ATTITUDE CHANGES.	AUTOMATIC	DEDICATED STELLAR MISSION
ORBITAL ANALYSIS	ATTITUDE/MANEUVER TIMELINE GENERATION (MULTIDISCIPLINE)	GENERATE ATTITUDE TIMELINE	GENERATE ATTITUDE TIMELINE	GENERATE AN ATTITUDE TIMELINE WHERE THE MANEUVER TIMELINE IS PROVIDED BY THE "MISSION TIMELINE GENERATION" SUBFUNCTION AND THE KEYWORD FILE IS DEVELOPED AS PART OF THIS TASK.	AUTOMATIC	ROUTINE

FUNCTION	SUBFUNCTION	TASK	SUBTASK	ACTIVITY OBJECTIVE	METHOD	NEED
ORBITAL ANALYSIS	ATTITUDE/MANEUVER TIMELINE GENERATION (MULTIDISCIPLINE)	EDIT CURRENT ATTITUDE T/L TO INCORPORATE STS OR OTHER REQMTS	EDIT CURRENT ATTITUDE T/L TO INCORPORATE STS OR OTHER REQMTS	EDIT CURRENT ATTITUDE DATA TO INCLUDE ADDITIONS OR CHANGES BASED ON STS OR OTHER REQUIREMENTS/CONSTRAINTS (THIS MAY ONLY INVOLVE MINOR UPDATES TO THE PRELIMINARY ATTITUDE TIMELINE).	AUTOMATIC	ROUTINE
ORBITAL ANALYSIS	ATTITUDE/MANEUVER TIMELINE GENERATION (DEDICATED STELLAR)	GENERATE MANEUVER TIMELINE (DS)	GENERATE MANEUVER TIMELINE (DS)	GENERATE A MANEUVER TIMELINE BY DEFINING THE MANEUVERS REQUIRED TO GO BETWEEN TARGET ATTITUDES WITH EIGEN AXIS MANEUVERS.	AUTOMATIC	DEDICATED STELLAR MISSION
ORBITAL ANALYSIS	ATTITUDE/MANEUVER TIMELINE GENERATION (DEDICATED STELLAR)	GENERATE ATTITUDE TIMELINE (DS)	GENERATE ATTITUDE TIMELINE (DS)	GENERATE AN ATTITUDE TIMELINE USING A KEYWORD FILE (TABLES) AND A MANEUVER TIMELINE AS INPUT FROM PROGRAM PAAC.	AUTOMATIC	DEDICATED STELLAR MISSION
ORBITAL ANALYSIS	ATTITUDE/MANEUVER TIMELINE GENERATION (DEDICATED STELLAR)	EDIT TO INCORPORATE STS OR OTHER REQMTS (DS)	EDIT TO INCORPORATE STS OR OTHER REQMTS (DS)	EDIT CURRENT ATTITUDE DATA TO INCLUDE ADDITIONS OR CHANGES BASED ON STS OR OTHER REQUIREMENTS/CONSTRAINTS (DEVELOPED FOR DEDICATED STELLAR MISSIONS).	AUTOMATIC	DEDICATED STELLAR MISSION

FUNCTION	SUBFUNCTION	TASK	SUBTASK	ACTIVITY OBJECTIVE	METHOD	NEED
ORBITAL ANALYSIS	ORBITER POINTING DATA GENERATION	GENERATE ORBITER POINTING DATA	GENERATE ORBITER POINTING DATA	GENERATE A TIME HISTORY OF THE ORBITER ATTITUDE AND COMPUTE BODY-REFERENCED POINTING DIRECTIONS FOR VARIOUS ORBIT-RELATED ITEMS (VELOCITY VECTOR, ANGULAR MOMENTUM VECTOR, ETC.), CELESTIAL OBJECTS (SUN,MOON), AND TDRS AS A FUNCTION OF TIME.	AUTOMATIC	ROUTINE
ORBITAL ANALYSIS	TDRS ACQ/LOSS GENERATION	GENERATE TDRS COVERAGE	GENERATE TDRS COVERAGE	GENERATE TDRS COVERAGE BASED ON THE LATEST ATTITUDE DATA.	AUTOMATIC	ROUTINE
ORBITAL ANALYSIS	TDRS ACQ/LOSS GENERATION	PROCESS TDRS DATA FOR ENHANCEMENT	PROCESS TDRS DATA FOR ENHANCEMENT	PROCESS TDRS AND GROUND STATION ACQUISITION/LOSS TIME DATA THROUGH UNIONS AND INTERSECTIONS TO ENHANCE USABILITY OF THIS DATA.	AUTOMATIC	ROUTINE
ORBITAL ANALYSIS	POCC MMU DATA SET GENERATION	GENERATE POCC MMU DATA SET	GENERATE POCC MMU DATA SET	REFORMAT DATA AND GENERATE A FILE (USER DATA SET) FOR USE BY THE ONBOARD EXPERIMENT COMPUTER OPERATING SYSTEM (ECOS) TIMELINE MAINTENANCE SYSTEM.	AUTOMATIC	ROUTINE
ORBITAL ANALYSIS	OBJECTIVE LOADS GENERATION	GENERATE CANDIDATE SOLAR GUIDE STARS	GENERATE CANDIDATE SOLAR GUIDE STARS	DETERMINE ACCEPTABLE GUIDE STARS AVAILABLE FOR IPS SOLAR POINTING.	AUTOMATIC	IPS SOLAR MISSION

ACTIVITY SUMMARY DATA

FUNCTION	SUBFUNCTION	TASK	SUBTASK	ACTIVITY OBJECTIVE	METHOD	NEED
ORBITAL ANALYSIS	OBJECTIVE LOADS GENERATION	DEVELOP STRAY LIGHT CONSTRAINTS	DEVELOP STRAY LIGHT CONSTRAINTS	DEVELOP STRAY LIGHT CONSTRAINTS BY PLOTTING THE FIELDS OF VIEW ABOUT GUIDE STARS AND CERTAIN OTHER VECTORS IN THE ORBITER COORDINATE SYSTEM. THIS IS DONE TO DETECT SOURCES OF STRAY LIGHT (REFLECTION OF THE SUN OFF THE ORBITER) THAT WOULD INTERFERE WITH IPS TARGET ACQUISITION AND TRACKING.	AUTOMATIC	IPS SOLAR MISSION
ORBITAL ANALYSIS	OBJECTIVE LOADS GENERATION	CHOOSE SOLAR GUIDE STARS	CHOOSE SOLAR GUIDE STARS	FROM CANDIDATE GUIDE STARS, CHOOSE THE SOLAR GUIDE STARS TO BE USED IN GENERATING OBJECTIVE LOADS. SELECTION OF GUIDE STARS ARE BASED PRIMARILY ON STRAY LIGHT CONSIDERATIONS.	MANUAL	IPS SOLAR MISSION
ORBITAL ANALYSIS	OBJECTIVE LOADS GENERATION	GENERATE SOLAR OBJECTIVE LOADS	GENERATE SOLAR OBJECTIVE LOADS	GENERATE AN OBJECTIVE LOAD FILE AND AN OBJECTIVE LOAD SUMMARY. THE OBJECTIVE LOADS WILL RESIDE IN THE MMU AND BE USED BY THE INSTRUMENT POINTING SYSTEM (IPS) TO ACQUIRE AND TRACK SOLAR TARGETS OF INTEREST AS A FUNCTION OF ORBITAL POSITION.	AUTOMATIC	IPS SOLAR MISSION
ORBITAL ANALYSIS	OBJECTIVE LOADS GENERATION	GENERATE CANDIDATE STELLAR GUIDE STARS (DS)	GENERATE CANDIDATE STELLAR GUIDE STARS (DS)	DETERMINE ACCEPTABLE GUIDE STARS AVAILABLE FOR IPS STELLAR POINTING.	AUTOMATIC	IPS MISSION (DEDICATED STELLAR)

FUNCTION	SUBFUNCTION	TASK	SUBTASK	ACTIVITY OBJECTIVE	METHOD	NEED
ORBITAL ANALYSIS	OBJECTIVE LOADS GENERATION	FORMAT STELLAR GUIDE STAR CATALOG (DS)	FORMAT STELLAR GUIDE STAR CATALOG (DS)	PROVIDE A GUIDE STAR CATALOG WHICH CONTAINS INFORMATION ON STARS RELATIVE TO THEIR LOCATION IN THE CELESTIAL SPHERE AND RELATIVE TO THEIR LOCATION IN THE IPS STAR TRACKERS.	AUTOMATIC	IPS MISSION (DEDICATED STELLAR)
ORBITAL ANALYSIS	OBJECTIVE LOADS GENERATION	SELECT IPS ROLL ANGLES (DS)	SELECT IPS ROLL ANGLES (DS)	DETERMINE THE IPS ROLL ANGLES FOR USE IN STELLAR OBSERVATIONS WHILE MINIMIZING THESE ROLLS BETWEEN OBSERVATIONS.	AUTOMATIC	IPS MISSION (DEDICATED STELLAR)
ORBITAL ANALYSIS	OBJECTIVE LOADS GENERATION	GENERATE STELLAR OBJECTIVE LOADS (DS)	GENERATE STELLAR OBJECTIVE LOADS (DS)	GENERATE AN OBJECTIVE LOAD FILE AND AN OBJECTIVE LOAD SUMMARY. THE OBJECTIVE LOADS WILL RESIDE IN THE MMU AND BE USED BY THE INSTRUMENT POINTING SYSTEM (IPS) TO ACQUIRE AND TRACK STELLAR TARGETS OF INTEREST AS A FUNCTION OF ORBITAL POSITION.	AUTOMATIC	IPS MISSION (DEDICATED STELLAR)
ORBITAL ANALYSIS	JOINT OPERATIONS TARGET FILE GENERATION(DEDICATED STELLAR)	GENERATE IPS POINTING DATA (DS)	GENERATE IPS POINTING DATA (DS)	REORGANIZE SCIENCE TARGET DATA AND POINTING DATA FOR INPUT INTO THE JOTF PROGRAM AND TO ALLOW THE PI'S TO EDIT DATA TO ADD SEQUENCE NUMBERS TO THE SCIENCE TARGETS.	AUTOMATIC	DEDICATED STELLAR MISSION
ORBITAL ANALYSIS	JOINT OPERATIONS TARGET FILE GENERATION(DEDICATED STELLAR)	PI EDITS TO ADD SEQUENCE NUMBER (DS)	PI EDITS TO ADD SEQUENCE NUMBER (DS)	THE PI EDITS THE ID FILE TO ADD A SEQUENCE NUMBER FOR USE BY HIS ONBOARD DEDICATED EXPERIMENT PROCESSER (DEP) WHICH PERFORMS SPECIFIC OPERATIONS RELATIVE TO A PARTICULAR SEQUENCE NUMBER.	MANUAL	DEDICATED STELLAR MISSION

FUNCTION	SUBFUNCTION	TASK	SUBTASK	ACTIVITY OBJECTIVE	METHOD	NEED
ORBITAL ANALYSIS	JOINT OPERATIONS TARGET FILE GENERATION(DEDICATED STELLAR)	GENERATE JOINT OPERTIONS TARGET FILE (DS)	GENERATE JOINT OPERATIONS TARGET FILE (DS)	GENERATE THE JOTF FILE (JOTF DATA SET) TO BE LOADED ON THE MMU. THE FILE CONTAINS DATA FOR EACH OBSERVATION TO BE CALLED UP AND VIEWED BY THE CREW ONBOARD.	AUTOMATIC	DEDICATED STELLAR MISSION
MISSION TIMELINE ANALYSIS	CREATE MISSION TIMELINE MODELS	CREATE MISSION TIMELINE MODELS	CREATE MISSION TIMELINE MODELS	CREATE MISSION TIMELINE MODELS AND WRITE THE ESS MODEL FILE. THIS SUBFUNCTION INCLUDES BUILDING EXPERIMENT MODELS, CREW CYCLE MODELS AND SL SYSTEM MODELS AS WELL AS MISSION LEVEL DATA.	MANUAL/AUTOMATIC	ROUTINE
MISSION TIMELINE ANALYSIS	GENERATE CREW W/O CYCLE	GENERATE CREW W/O CYCLE	GENERATE CREW W/O CYCLE	USING THE BASIC CREW CYCLE FROM JSC AND THE CREW CYCLE MODELS GENERATED IN THE CREATE MISSION TIMELINE MODELS SUBFUNCTION AS INPUT, GENERATE THE CREW W/O CYCLE.	MANUAL	ROUTINE
MISSION TIMELINE ANALYSIS	CREATE ESS TARGET FILE	CREATE ESS TARGET FILE	CREATE ESS TARGET FILE	REFORMAT TARGET, ATTITUDE AND TDRS O/O FILES INTO THE ESS FORMAT. BUILD NEW SUBJECTS/SPECIAL TARGETS IF REQUIRED. EDIT DATA IF REQUIRED. PERFORM STATISTICAL TARGET ANALYSIS TO PREDICT POTENTIAL INCOMPATIBILITIES BETWEEN THE ESS MODELS AND THE ESS TARGETS. THIS SUBTASK IS PERFORMED A MINIMUM OF THREE TIMES PER CYCLE. ONCE FOR INITIAL INPUT TO THE MISSION TL GENERATION SUBTASK AND TWICE MORE DURING ATTITUDE/TDRS ITERATION/UPDATES.	AUTOMATIC	ROUTINE

ACTIVITY SUMMARY DATA

FUNCTION	SUBFUNCTION	TASK	SUBTASK	ACTIVITY OBJECTIVE	METHOD	NEED
MISSION TIMELINE ANALYSIS	MISSION TIMELINE GENERATION	GENERATE MISSION TIMELINE	GENERATE MISSION TIMELINE	BUILD SELECTION GROUPS, PRIORITIES, GRADING CRITERIA, ETC. AS A BASIS FOR SCHEDULING; SCHEDULE THE CREW CYCLE AND SYSTEM MODELS; SCHEDULE EXPERIMENTS; SCHEDULE PAO TV & PHOTO ACTIVITY; AND GENERATE MISSION TIMELINE OUTPUT FILES & DOCUMENTATION	PRIMARILY AUTOMATIC	ROUTINE
MISSION TIMELINE ANALYSIS	MISSION TIMELINE GENERATION	FINALIZE MISSION TIMELINE	FINALIZE MISSION TIMELINE	PERFORM NECESSARY SUBTASKS OF THE GENERATE MISSION TIMELINE TASK,USING THE UPDATES/MODIFICATIONS FROM THE REVIEW CYCLE TO GENERATE A FINAL MISSION TIMELINE.	PRIMARILY MANUAL	ROUTINE
MISSION TIMELINE ANALYSIS	PAYLOAD CREW ACTIVITY PLAN DEVELOPMENT	GENERATE PCAP CHARTS	GENERATE PCAP CHARTS	DESIGN THE LAYOUT OF THE CHARTS, DEVELOP PCAP PROCEDURES, DEVELOP NOTES AND GENERATE THE PCAP CHARTS.	AUTOMATIC	ROUTINE
MISSION TIMELINE ANALYSIS	PAYLOAD CREW ACTIVITY PLAN DEVELOPMENT	GENERATE PTS CHARTS	GENERATE PTS CHARTS	DESIGN THE LAYOUT OF AND PRODUCE THE PAYLOAD TIMELINE SUMMARY (PTS) CHARTS.	AUTOMATIC	ROUTINE
MISSION TIMELINE ANALYSIS	PAYLOAD CREW ACTIVITY PLAN DEVELOPMENT	BUILD PCAP DOCUMENT	BUILD PCAP DOCUMENT	COLLECT THE INFORMATION, ORGANIZE, BIND AND TAB THE PAYLOAD CREW ACTIVITY PLAN (PCAP) DOCUMENTS.	MANUAL	ROUTINE

....

FUNCTION	SUBFUNCTION	TASK	SUBTASK	ACTIVITY OBJECTIVE	METHOD	NEED
FLIGHT DEFINITION DOCUMENT DEVELOPMENT	FLIGHT DEFINITION DOCUMENT DEVELOPMENT	FLIGHT DEFINITION DOCUMENT DEVELOPMENT	FLIGHT DEFINITION DOCUMENT DEVELOPMENT	PREPARE THE FLIGHT DEFINITION DOCUMENT TO PROVIDE A MISSION DESCRIPTION TO BE USED BY SUPPORTING ELEMENTS FOR DESIGN AND OPERATIONS PLANNING FOR THE PAYLOAD. THE FDD IS ALSO USED TO DESCRIBE SCHEDULED OPERATIONS OF THE INDIVIDUAL EXPERIMENTS AND THE SUPPORTING RESOURCE REQUIREMENTS.	MANUAL	ROUTINE
FLIGHT PLANNING ANNEX INPUT DEVELOPMENT	FLIGHT PLANNING ANNEX INPUT DEVELOPMENT	FLIGHT PLANNING ANNEX INPUT DEVELOPMENT	FLIGHT PLANNING ANNEX INPUT DEVELOPMENT	PREPARE THE FLIGHT PLANNING ANNEX INPUTS CONTAINING AGREEMENTS BETWEEN THE PYLD AND THE STS ON MATTERS WHICH RELATE TO THE ANALYSIS AND IMPLEMENTATION OF PAYLOAD FLIGHT DESIGN REQUIREMENTS ON THE STS (PART I - ELECTRICAL POWER, ENERGY AND COOLING REQUIREMENTS) (PART II - FLIGHT ACTIVITY PLANNING) (PART III - TRAJECTORY DESIGN). THE ANNEX IS INTENDED TO SUPPLEMENT THE PIP IN PROVIDING ADDITIONAL DETAILS TO FACILITATE MISSION AND FLIGHT OPERATIONS PLANNING.	MANUAL	ROUTINE
CREW PROCEDURES DEVELOPMENT	DEVELOP STOWAGE BOOK	DEVELOP STOWAGE BOOK	DEVELOP STOWAGE BOOK	DEVELOP A BOOK CONTAINING A LIST OF ALL EQUIPMENT STORED ONBOARD AND IT'S LOCATION.	MANUAL	ROUTINE

FUNCTION	SUBFUNCTION	TASK	SUBTASK	ACTIVITY OBJECTIVE	METHOD	NEED
CREW PROCEDURES DEVELOPMENT	DEVELOP TV, PHOTO PROCEDURES	DEVELOP TV, PHOTO PROCEDURES	DEVELOP TV, PHOTO PROCEDURES	GENERATE DETAILED PROCEDURES, BASED ON PI REQUIREMENTS, FOR ALL PAYLOAD TV AND PHOTO OPERATIONS. GENERATE DESIRED SCENES, WHICH CAMERAS TO USE, BEST SET-UP & PERIPHERALS NEEDED (TRIPODS ETC). INCLUDE ACTUAL PHOTOS OF WHAT EACH SCENE IS TO LOOK LIKE.	MANUAL	ROUTINE
CREW PROCEDURES DEVELOPMENT	DEVELOP EXPERIMENT CREW PROCEDURES	DEVELOP EXPERIMENT CREW PROCEDURES	DEVELOP EXPERIMENT CREW PROCEDURES	DEVELOP DETAILED CREW PROCEDURES FOR EACH EXPERIMENT. PROCEDURES MUST CONTAIN EXPERIMENT ACTIVATION/DEACTIVATION PROCEDURES, NOMINAL OPERATIONS PROCEDURES, AND MALFUNCTION PROCEDURES.	MANUAL	ROUTINE
CREW PROCEDURES DEVELOPMENT	DEVELOP PAYLOAD SYSTEMS HANDBOOK	DEVELOP PAYLOAD SYSTEMS HANDBOOK	DEVELOP PAYLOAD SYSTEMS HANDBOOK	DEVELOP DETAILED CREW PROCEDURES FOR PL COMPLEMENT ACTIVATION/ DEACTIVATION, REQUIRED MISSION PECULIAR EQUIPMENT OPERATIONS, AND MALFUNCTION PROCEDURES FOR PAYLOAD COMPLEMENT EQUIPMENT/INTERFACES ANOMALOUS CONDITIONS.	MANUAL	ROUTINE
CREW PROCEDURES DEVELOPMENT	DEVELOP CDMS DICTIONARY	DEVELOP CDMS DICTIONARY	DEVELOP CDMS DICTIONARY	DEVELOP A DOCUMENT DESCRIBING ALL PAYLOAD DISPLAYS.	MANUAL	ROUTINE
CREW PROCEDURES DEVELOPMENT	BUILD PFDF DOCUMENTS	BUILD PFDF DOCUMENTS	BUILD PFDF DOCUMENTS	PERFORM THE WORD PROCESSING, COPYING, TABBING,ETC., REQUIRED TO BUILD THE PFDF DOCUMENTS.	MANUAL	ROUTINE
DATA FLOW ANALYSIS	CREATE DATA FLOW MODELS	CREATE DATA FLOW MODELS	CREATE DATA FLOW MODELS	DEVELOP THE REQUIRED DATA FLOW MODELS FROM DATA EXTRACTED FROM THE IPRD AND O&IA DOCUMENTS, AND FROM DIRECT PI INTERFACE WHEN REQUIRED.	MANUAL	ROUTINE

FUNCTION	SUBFUNCTION	TASK	SUBTASK	ACTIVITY OBJECTIVE	METHOD	NEED
DATA FLOW ANALYSIS	GENERATE MISSION DATA REQUIREMENTS PROFILE	GENERATE MISSION DATA REQUIREMENTS PROFILE	GENERATE MISSION DATA REQUIREMENTS PROFILE	CREATE A FILE OF DATA REQUIREMENTS FOR: A) DIGITAL DATA OVER DEDICATED CHANNELS, B) ALL A/V SIGNALS, C) ALL DIRECT ACCESS CHANNEL SIGNALS, D) ALL EXPERIMENT ECIO AND ECIO SUBSETS	AUTOMATIC	ROUTINE
DATA FLOW ANALYSIS	SCHEDULE ONBOARD DATA MANAGEMENT AND DOWNLINK	GENERATE MISSION WINDOWS	GENERATE MISSION WINDOWS	DEFINE TDRS COVERAGE AND IDENTIFY OVERLAPS FOR MULTIPLE SATELLITES, WINDOWS OF OPPORTUNITY FOR REALTIME DATA DOWNLINK, WINDOWS OF OPPORTUNITY FOR RECORDER DUMPS, AND REQUIRED HIGH DATA RATE RECORDER (HDRR) RECORD WINDOWS BASED ON TDRS COVERAGE.	AUTOMATIC	ROUTINE
DATA FLOW ANALYSIS	SCHEDULE ONBOARD DATA MANAGEMENT AND DOWNLINK	SCHEDULE ONBOARD RECORDER OPERATIONS	SCHEDULE ONBOARD RECORDER OPERATIONS	SCHEDULE REALTIME DOWNLINK OF ANALOG/VIDEO AND DIGITAL DATA, A FILL/DUMP PLAN FOR THE DIGITAL HDRR, A FILL/DUMP PLAN FOR THE ANALOG/VIDEO TAPE RECORDERS, RECORDING ON THE VIDEO CASSETTE RECORDERS (THE USER MUST COMMAND THE RECORDER DUMPS AND CHANGEOUTS).	AUTOMATIC	ROUTINE
DATA FLOW ANALYSIS	SCHEDULE ONBOARD DATA MANAGEMENT AND DOWNLINK	GENERATE HRM POSSIBLE FORMATS	GENERATE HRM POSSIBLE FORMATS	IDENTIFY ALL FORANTS POSSIBLE AT ANY GIVEN TIME DURING A MISSION CONSIDERING ACTIVE EXPERIMENTS WITH DIGITAL DATA STREAMS, DIGITAL DUMPS (HDRR AND PAYLOAD RECORDER (PLR)), ANALOG/VIDEO DOWNLINK (REAL TIME AND DUMP), AND THE DOWNLINK OF DACH.	AUTOMATIC	ROUTINE

FUNCTION	SUBFUNCTION	TASK	SUBTASK	ACTIVITY OBJECTIVE	METHOD	NEED
DATA FLOW ANALYSIS	SCHEDULE ONBOARD DATA MANAGEMENT AND DOWNLINK	SCHEDULE HRM FORMATS AND DOWNLINK	SCHEDULE HRM FORMATS AND DOWNLINK	FROM THE HRM FORMATS AVAILABLE DURING A SPACELAB MISSION, SELECT OPTIMUM FORMAT TIMELINE, SCHEDULE KUSP CHANNEL USAGE, SELECT TDRS HANDOVERS, AOS EVALUATION PERIOD - EFFECTIVE AOS TO EFFECTIVE LOS, LOS EVALUATION PERIOD - EFFECTIVE LOS TO EFFECTIVE AOS.	AUTOMATIC	ROUTINE
DATA FLOW ANALYSIS	SCHEDULE POCC DATA CAPTURE/MANAGEMENT/DISTRIBUTION	GENERATE POCC POSSIBLE CONFIGURATIONS	GENERATE POCC POSSIBLE CONFIGURATIONS	IDENTIFY THE LIST OF POSSIBLE REAL TIME POCC CONFIGURATIONS BASED ON THE DATA REQUIREMENTS PROFILE AND THE HDRR DUMP SCHEDULE.	AUTOMATIC	ROUTINE
DATA FLOW ANALYSIS	SCHEDULE POCC DATA CAPTURE/MANAGEMENT/DISTRIBUTION	SCHEDULE POCC CONFIGURATIONS	SCHEDULE POCC CONFIGURATIONS	GENERATE A SCHEDULE OF CONFIGURATIONS FOR ROUTING REAL-TIME DATA WITHIN THE POCC.	AUTOMATIC	ROUTINE
DATA FLOW ANALYSIS	SCHEDULE POCC DATA CAPTURE/MANAGEMENT/DISTRIBUTION	SCHEDULE RECORDER PLAYBACKS	SCHEDULE RECORDER PLAYBACKS	GENERATE A SCHEDULE OF PLAYBACKS FOR THE HDRR. SCHEDULE TIME PERIODS IN WHICH THE DATA WILL BE PLAYED BACK AND IDENTIFY THE PLAYBACK CONFIGURATIONS.	AUTOMATIC	ROUTINE
DATA FLOW ANALYSIS	VERIFICATION OF DATA FLOW SCHEDULES	VERIFY DATA FLOW SCHEDULES	VERIFY DATA FLOW SCHEDULES	INSURE THAT LIMITATIONS (MISSION WINDOWS, HRM FORMATS, POCC CONFIGURATIONS AND TDRS AVAILABILITY) HAVE NOT BEEN VIOLATED BY THE USER WHEN UPDATING/ENHANCING THE DATA FLOW SCHEDULES.	AUTOMATIC	ROUTINE

FUNCTION	SUBFUNCTION	TASK	SUBTASK	ACTIVITY OBJECTIVE	METHOD	NEED
DATA FLOW ANALYSIS	DATA FLOW AND SYSTEMS CONFIGURATION DOCUMENT DEVELOPMENT	GENERATE DATA FLOW REPORTS	GENERATE DATA FLOW REPORTS	CREATE TABULAR AND PLOT REPORT INFORMATION. THESE REPORTS RANGE FROM SPECIFIC TYPE REPORTS FOR ONE SPECIAL PHASE OF DATA FLOW TO GENERAL REPORTS THAT REFLECT ALL ONBOARD ACTIVITY. THE USER MAY RUN THESE REPORTS FOR A GIVEN TIME SLICE OR FOR THE ENTIRE MISSION.	AUTOMATIC	ROUTINE
DATA FLOW ANALYSIS	UPDATE OR ENHANCE EXISTING SCHEDULE	UPDATE OR ENHANCE EXISTING SCHEDULE	UPDATE OR ENHANCE EXISTING SCHEDULE	ENHANCE AN EXISTING SCHEDULE, ADAPT AN OLD SCHEDULE TO A NEW TDRS PROFILE, OR INCORPORATE NEW DIGITAL OR ANALOG/VIDEO REQUIREMENTS INTO AN EXISTING SCHEDULE.	AUTOMATIC	ROUTINE
MMU LOAD INPUT DEVELOPMENT	CREATE ECOS SUBORDINATE TIMELINES	CREATE SUBORDINATE TIMELINES	CREATE SUBORDINATE TIMELINES	RECEIVE TIMELINE COMMANND INPUTS FROM THE PI'S AND GUIDELINES FROM THE O&IA DOCUMENT AND CREATE SUBORDINATE TIMELINES AS NECESSARY TO ACCOMPLISH EACH PI'S OBJECTIVES (IF COMMANDS ARE VERY FEW THEY ARE INCORPORATED DIRECTLY INTO THE MASTER TIMELINE).	MANUAL/AUTOMATIC	ROUTINE
MMU LOAD INPUT DEVELOPMENT	CREATE ECOS SUBORDINATE TIMELINES	CHECK STL SYNTAX	CHECK STL SYNTAX	VERIFY ALL SUBORDINATE TIMELINES ARE LEGAL AND WITHOUT TYPOGRAPHICAL ERROR.	AUTOMATIC	ROUTINE
MMU LOAD INPUT DEVELOPMENT	CREATE ECOS SUBORDINATE TIMELINES	DESKTOP STL OPERTIONAL VERIFICATION	DESKTOP STL OPERATIONAL VERIFICATION	VERIFY THAT EACH SUBORDINATE TIMELINE COMPLETES THE OBJECTIVES OF THE P.I. AND DOES NOT CAUSE PERTURBATIONS TO OTHER EXPERIMENTS.	MANUAL	ROUTINE

ACTIVITY SUMMARY DATA

FUNCTION	SUBFUNCTION	TASK	SUBTASK	ACTIVITY OBJECTIVE	METHOD	NEED
MMU LOAD INPUT DEVELOPMENT	CREATE ECOS MASTER TIMELINE	CREATE MASTER INPUT FILES	CREATE MASTER INPUT FILES	ASSEMBLE MISSION TIMELINE INFORMATION AND ARRANGE IN CHRONOLOGICAL ORDER INTO ONE OR SEVERAL MASTER TIMELINES, AS NEEDED. MULTIPLE TIMELINES ARE ACTIVATED SERIALLY DURING A MISSION.	MANUAL	ROUTINE
MMU LOAD INPUT DEVELOPMENT	CREATE ECOS MASTER TIMELINE	VERIFY AND COMBINE MASTER INPUT FILES	VERIFY AND COMBINE MASTER INPUT FILES	ASSURE THAT ALL MASTER TIMELINE INPUT FILES ARE LEGAL AND FREE OF TYPOGRAPHICAL ERRORS. MERGE ALL FILES INTO ONE.	AUTOMATIC	ROUTINE
MMU LOAD INPUT DEVELOPMENT	CREATE ECOS MASTER TIMELINE	GENERATE MASTER TIMELINE	GENERATE MASTER TIMELINE	COMBINE ALL MASTER INPUT FILES INTO ONE COMPLETE MASTER TIMELINE.	AUTOMATIC	ROUTINE
MMU LOAD INPUT DEVELOPMENT	CREATE ECOS MASTER TIMELINE	VERIFY MASTER TIMELINE	VERIFY MASTER TIMELINE	VERIFY ALL COMMANDS AND SUBORDINATE TIMELINE CALLS ARE VALID FOR ENTIRE MISSION.	AUTOMATIC	ROUTINE
MMU LOAD INPUT DEVELOPMENT	CREATE ECOS MASTER TIMELINE	GENERATE STL BUFFER UTILIZATION REPORT	GENERATE STL BUFFER UTILIZATION REPORT	SIMULATE THE ACTIVATION AND DE-ACTIVATION OF SUBORDINATE TIMELINES FOR AN ENTIRE MISSION TO VERIFY THAT NO MORE THAN 6 ARE ACTIVE AT ANY ONE TIME.	AUTOMATIC	ROUTINE
MMU LOAD INPUT DEVELOPMENT	CREATE ECOS MASTER TIMELINE	DESKTOP MTL OPERATIONAL VERIFICATION	DESKTOP MTL OPERATIONAL VERIFICATION	VERIFY THAT THE MASTER TIMELINE IS FREE OF ERRORS.	MANUAL	ROUTINE
MMU LOAD INPUT DEVELOPMENT	BUILD ECOS TIMELINE TAPE	CONVERT TO IBM TAPE FORMAT AND VERIFY	CONVERT TO IBM TAPE FORMAT AND VERIFY	CONVERT ECOS TIMELINE FILE FROM ASCII TO EBCDIC.	AUTOMATIC	ROUTINE

FUNCTION	SUBFUNCTION	TASK	SUBTASK	ACTIVITY OBJECTIVE	METHOD	NEED
MMU LOAD INPUT DEVELOPMENT	BUILD ECOS TIMELINE TAPE	GENERATE ECOS TIMELINE DOCUMENT	GENERATE ECOS TIMELINE DOCUMENT	INCORPORATE THE ECOS TIMELINE PRINTOUT INTO A DOCUMENT.	MANUAL	ROUTINE
MMU LOAD INPUT DEVELOPMENT	MMU OPTIMIZATION	CREATE MMU ALLOCATION FILE	CREATE MMU ALLOCATION FILE	CREATE A FILE WHICH SIMULATES THE LOCATION OF ALL FILES ON THE MMU TAPE.	MANUAL/AUTOMATIC	ROUTINE
MMU LOAD INPUT DEVELOPMENT	MMU OPTIMIZATION	EVALUATE MMU TAPE MOVEMENT	EVALUATE MMU TAPE MOVEMENT	FIND THE BEST LOCATION FOR FILES ON THE MMU TAPE TO REDUCE THE AMOUNT OF TAPE MOVEMENT. APPROX. 5 OUTPUTS FROM THIS AND TASK "CREATE MMU ALLOCATION FILE" ARE GENERATED. THESE OUTPUTS ARE COMPARED TO EACH OTHER TO SELECT THE BEST CONFIGURATION.	AUTOMATIC	ROUTINE
EXPERIMENT COMMAND PLANNING DEVELOPMENT	CREATE COMMAND LIST	CREATE COMMAND LIST	CREATE COMMAND LIST	GATHER AND COMPILE ALL COMMANDS TO EXPERIMENTS THAT WILL BE PERFORMED DURING THE SUBJECT MISSION. ASSEMBLE ALL COMMANDS IN CHRONOLOGICAL ORDER IN A VAX FILE.	MANUAL/AUTOMATIC	ROUTINE
EXPERIMENT COMMAND PLANNING DEVELOPMENT	CHECK COMMAND SYNTAX	CHECK COMMAND SYNTAX	CHECK COMMAND SYNTAX	VERIFY ALL COMMANDS LISTED ARE LEGAL AND WITHOUT TYPOGRAPHICAL ERRORS.	MANUAL	ROUTINE
EXPERIMENT COMMAND PLANNING DEVELOPMENT	PRODUCE COMMAND TIMETAGS	PRODUCE COMMAND TIMETAGS	PRODUCE COMMAND TIMETAGS	APPEND A MISSION ELAPSED TIME TO ALL THE COMMANDS LISTED IN THE INPUT FILE.	AUTOMATIC	ROUTINE

FUNCTION	SUBFUNCTION	TASK	SUBTASK	ACTIVITY OBJECTIVE	METHOD	NEED
EXPERIMENT COMMAND PLANNING DEVELOPMENT	GENERATE COMMAND TIMELINE	GENERATE COMMAND TIMELINE	GENERATE COMMAND TIMELINE	PRODUCE THE COMMAND TIMELINE PRINTOUT.	AUTOMATIC	ROUTINE
EXPERIMENT COMMAND PLANNING DEVELOPMENT	CREATE POCC CHECKLIST	CREATE POCC CHECKLIST	CREATE POCC CHECKLIST	ACCUMULATE ALL THE POCC ACTIVITIES ON A LIST IN A VAX FILE.	MANUAL/AUTOMATIC	ROUTINE
EXPERIMENT COMMAND PLANNING DEVELOPMENT	CHECK ACTIVITY SYNTAX	CHECK ACTIVITY SYNTAX	CHECK ACTIVITY SYNTAX	VERIFY ALL ACTIVITIES LISTED ARE CORRECT AND WITHOUT TYPOGRAPHICAL ERRORS.	AUTOMATIC	ROUTINE
EXPERIMENT COMMAND PLANNING DEVELOPMENT	PRODUCE ACTIVITY TIMETAGS	PRODUCE ACTIVITY TIMETAGS	PRODUCE ACTIVITY TIMETAGS	TO APPEND A MET TIME TO ALL ACTIVITIES LISTED IN THE INPUT FILE AND TO COMBINE ALL FILES INTO ONE.	MANUAL	ROUTINE
EXPERIMENT COMMAND PLANNING DEVELOPMENT	GENERATE POCC CHECKLIST AND COMMAND TIMELINE	GENERATE POCC CHECKLIST AND COMMAND TIMELINE	GENERATE POCC CHECKLIST AND COMMAND TIMELINE	MERGE THE INPUT FILES TO PRODUCE A SCHEDULE OF ON-ORBIT ACTIVITIES AND CORRESPONDING POCC ACTIVITIES.	AUTOMATIC	ROUTINE

TABLE 2
ACTIVITY TIME AND SKILL REQUIREMENTS

```
                          ACTIVITY TIME AND SKILL REQUIREMENTS                     DATE 04/08/87

                                                                                   PAGE        1

                                                    CALENDAR                  SKILL LEVEL          MANPOWER
ACTIVITY                                      CYCLE TIME(DAYS)  SKILL TYPE  (1-NOV,2-PRO,3-EXP)  (MAN-HOURS)
............................................  ..... ..........  ..........  ...................  ..........
PAYLOAD DATA COLLECTION                         B          10  P/L DATA COL                  3          80
PAYLOAD DATA COLLECTION                         P          30  P/L DATA COL                  3         160
PAYLOAD DATA COLLECTION                         U           5  P/L DATA COL                  3          40
ORBIT REQUIREMENTS EVALUATION AND SELECTION     B           2  ORBIT                         2          16
ORBIT REQUIREMENTS EVALUATION AND SELECTION     P           5  ORBIT                         3          40
ORBIT REQUIREMENTS EVALUATION AND SELECTION     U           1  ORBIT                         2           8
LAUNCH WINDOW/LAUNCH TIME SELECTION             B           2  ORBIT                         3          16
LAUNCH WINDOW/LAUNCH TIME SELECTION             P           5  ORBIT                         3          40
LAUNCH WINDOW/LAUNCH TIME SELECTION             U           2  ORBIT                         3          16
GENERATE STATE VECTOR                           P           1  ORBIT                         2           4
CONVERT/STORE STATE VECTOR                      B           0  ORBIT                         1           1
CONVERT/STORE STATE VECTOR                      P           0  ORBIT                         1           1
CONVERT/STORE STATE VECTOR                      R           0  ORBIT                         1           1
CONVERT/STORE STATE VECTOR                      U           0  ORBIT                         1           1
GENERATE ORBITAL EPHEMERIS BY NUMERICAL         B           1  ORBIT                         2           4
INTEGRATION
GENERATE ORBITAL EPHEMERIS BY NUMERICAL         P           1  ORBIT                         2           4
INTEGRATION
GENERATE ORBITAL EPHEMERIS BY NUMERICAL         R           0  ORBIT                         2           1
INTEGRATION
GENERATE ORBITAL EPHEMERIS BY NUMERICAL         U           1  ORBIT                         2           4
INTEGRATION
GENERATE REQUIRED EPHEMERIS DATA FOR OUTPUT     B           1  ORBIT                         2           4
GENERATE REQUIRED EPHEMERIS DATA FOR OUTPUT     P           1  ORBIT                         2           4
GENERATE REQUIRED EPHEMERIS DATA FOR OUTPUT     R           0  ORBIT                         2           1
GENERATE REQUIRED EPHEMERIS DATA FOR OUTPUT     U           1  ORBIT                         2           4
GENERATE EARTH SHADOW ACQ/LOSS                  B           0  ORBIT                         2           1
GENERATE EARTH SHADOW ACQ/LOSS                  P           0  ORBIT                         2           1
GENERATE EARTH SHADOW ACQ/LOSS                  R           0  ORBIT                         2           1
GENERATE EARTH SHADOW ACQ/LOSS                  U           0  ORBIT                         2           1
GENERATE SUN RISE/SET                           B           0  ORBIT                         1           1
GENERATE SUN RISE/SET                           P           0  ORBIT                         1           1
GENERATE SUN RISE/SET                           R           0  ORBIT                         1           1
GENERATE SUN RISE/SET                           U           0  ORBIT                         1           1
..........................................................................................................
```

C-3

```
                             ACTIVITY TIME AND SKILL REQUIREMENTS                 DATE 04/08/87

                                                                                  PAGE        2

                                                       CALENDAR                   SKILL LEVEL       MANPOWER
ACTIVITY                                        CYCLE  TIME(DAYS)  SKILL TYPE  (1-NOV,2-PRO,3-EXP)  (MAN-HOURS)
..............................................  .....  ..........  ..........  ...................  ..........
GENERATE MOON RISE/SET                            B          0     ORBIT                 2                1
GENERATE MOON RISE/SET                            P          0     ORBIT                 2                1
GENERATE MOON RISE/SET                            R          0     ORBIT                 2                1
GENERATE MOON RISE/SET                            U          0     ORBIT                 2                1
GENERATE PRELIMINARY TDRS COVERAGE                B          1     ORBIT                 2                1
GENERATE PRELIMINARY TDRS COVERAGE                P          1     ORBIT                 2                1
GENERATE PRELIMINARY TDRS COVERAGE                U          1     ORBIT                 2                1
GENERATE GROUND STATION COVERAGE                  B          0     ORBIT                 2                2
GENERATE GROUND STATION COVERAGE                  P          0     ORBIT                 2                2
GENERATE GROUND STATION COVERAGE                  R          0     ORBIT                 2                1
GENERATE GROUND STATION COVERAGE                  U          0     ORBIT                 2                2
GENERATE RADIATION ENVIRONMENT                    B          1     ORBIT                 2                4
GENERATE RADIATION ENVIRONMENT                    P          1     ORBIT                 2                4
GENERATE RADIATION ENVIRONMENT                    R          0     ORBIT                 2                1
GENERATE RADIATION ENVIRONMENT                    U          1     ORBIT                 2                4
IMPOSE RADIATION CONSTRAINTS                      B          0     ORBIT                 1                1
IMPOSE RADIATION CONSTRAINTS                      P          0     ORBIT                 1                1
IMPOSE RADIATION CONSTRAINTS                      R          0     ORBIT                 1                1
IMPOSE RADIATION CONSTRAINTS                      U          0     ORBIT                 1                1
MERGE MISSION INDEPENDENT TARGETS                 B          0     ORBIT                 1                1
MERGE MISSION INDEPENDENT TARGETS                 P          0     ORBIT                 1                1
MERGE MISSION INDEPENDENT TARGETS                 R          0     ORBIT                 1                1
MERGE MISSION INDEPENDENT TARGETS                 U          0     ORBIT                 1                1
DEVELOP CELESTIAL TARGETS (NON-IPS MISSIONS)      B          0     ORBIT                 2                1
DEVELOP CELESTIAL TARGETS (NON-IPS MISSIONS)      P          1     ORBIT                 2                4
DEVELOP CELESTIAL TARGETS (NON-IPS MISSIONS)      U          0     ORBIT                 2                1
DEVELOP CELESTIAL TARGETS (IPS MISSIONS)          B          1     ORBIT                 2                4
DEVELOP CELESTIAL TARGETS (IPS MISSION)           P          1     ORBIT                 2                4
DEVELOP CELESTIAL TARGETS (IPS MISSIONS)          U          1     ORBIT                 2                4
GENERATE CELESTIAL TARGET(S) ACQ/LOSS             B          1     ORBIT                 2                1
GENERATE CELESTIAL TARGET(S) ACQ/LOSS             P          1     ORBIT                 2                1
GENERATE CELESTIAL TARGET(S) ACQ/LOSS             R          0     ORBIT                 2                1
GENERATE CELESTIAL TARGET(S) ACQ/LOSS             U          1     ORBIT                 2                1
COMBINE CONSTRAINTS TO DETERMINE CELESTIAL        B          1     ORBIT                 2                4
TARGETS AND MERGE FILES
.........................................................................................................
```

ACTIVITY TIME AND SKILL REQUIREMENTS

ACTIVITY	CYCLE	CALENDAR TIME(DAYS)	SKILL TYPE	SKILL LEVEL (1-NOV,2-PRO,3-EXP)	MANPOWER (MAN-HOURS)
COMBINE CONSTRAINTS TO DETERMINE CELESTIAL TARGETS AND MERGE FILES	P	1	ORBIT	2	4
COMBINE CONSTRAINTS TO DETERMINE CELESTIAL TARGETS AND MERGE FILES	R	0	ORBIT	2	1
COMBINE CONSTRAINTS TO DETERMINE CELESTIAL TARGETS AND MERGE FILES	U	1	ORBIT	2	4
COMPUTE DISTANCE FROM TANGENT POINT ON THE ORBITER TO SUN LINE-OF-SIGHT TO THE EARTH SURFACE	B	1	ORBIT	2	4
COMPUTE DISTANCE FROM TANGENT POINT ON THE ORBITER TO SUN LINE-OF-SIGHT TO THE EARTH SURFACE	P	1	ORBIT	2	4
COMPUTE DISTANCE FROM TANGENT POINT ON THE ORBITER TO SUN LINE-OF-SIGHT TO THE EARTH SURFACE	R	0	ORBIT	2	1
COMPUTE DISTANCE FROM TANGENT POINT ON THE ORBITER TO SUN LINE-OF-SIGHT TO THE EARTH SURFACE	U	1	ORBIT	2	4
DEVELOP/APPLY CONSTRAINTS TO ATMOSPHERIC PHYSICS OBSERVATION PERIODS	B	0	ORBIT	2	1
DEVELOP/APPLY CONSTRAINTS TO ATMOSPHERIC PHYSICS OBSERVATION PERIODS	P	0	ORBIT	2	1
DEVELOP/APPLY CONSTRAINTS TO ATMOSPHERIC PHYSICS OBSERVATION PERIODS	R	0	ORBIT	2	1
DEVELOP/APPLY CONSTRAINTS TO ATMOSPHERIC PHYSICS OBSERVATION PERIODS	U	0	ORBIT	2	1
COMPUTE ORBIT TERMINATOR TARGETS	B	0	ORBIT	2	1
COMPUTE ORBIT TERMINATOR TARGETS	P	0	ORBIT	2	1
COMPUTE ORBIT TERMINATOR TARGETS	R	0	ORBIT	2	1
COMPUTE ORBIT TERMINATOR TARGETS	U	0	ORBIT	2	1
COMBINE CONSTRAINTS TO DETERMINE ATMOSPHERIC PHYSICS TARGETS	B	0	ORBIT	2	1
COMBINE CONSTRAINTS TO DETERMINE ATMOSPHERIC PHYSICS TARGETS	P	0	ORBIT	2	1

```
                                   ACTIVITY TIME AND SKILL REQUIREMENTS                  DATE 04/08/87

                                                                                         PAGE        4

                                                       CALENDAR                  SKILL LEVEL        MANPOWER
ACTIVITY                                         CYCLE TIME(DAYS)  SKILL TYPE    (1-NOV,2-PRO,3-EXP) (MAN-HOURS)
................................................ ..... ..........  ............  ...................  .........
COMBINE CONSTRAINTS TO DETERMINE ATMOSPHERIC       R          0  ORBIT                         2            1
PHYSICS TARGETS
COMBINE CONSTRAINTS TO DETERMINE ATMOSPHERIC       U          0  ORBIT                         2            1
PHYSICS TARGETS
COMPUTE SUN AZIMUTH AND ELEVATION FROM             R          1  ORBIT                         2            1
ORBITING VEHICLE WITH RESPECT TO SUN RISE/SET
EVENTS
DEVELOP CONSTRAINTS FOR SOLAR VIEWING PERIODS      B          0  ORBIT                         2            1
DEVELOP CONSTRAINTS FOR SOLAR VIEWING PERIODS      P          0  ORBIT                         2            1
DEVELOP CONSTRAINTS FOR SOLAR VIEWING PERIODS      R          0  ORBIT                         2            1
DEVELOP CONSTRAINTS FOR SOLAR VIEWING PERIODS      U          0  ORBIT                         2            1
COMBINE CONSTRAINTS TO DETERMINE SOLAR             B          0  ORBIT                         2            1
TARGETS
COMBINE CONSTRAINTS TO DETERMINE SOLAR             P          0  ORBIT                         2            1
TARGETS
COMBINE CONSTRAINTS TO DETERMINE SOLAR             R          0  ORBIT                         2            1
TARGETS
COMBINE CONSTRAINTS TO DETERMINE SOLAR             U          0  ORBIT                         2            1
TARGETS
CREATE EARTH SITE DEFINITION FILE                  B          0  ORBIT                         2            2
CREATE EARTH SITE DEFINITION FILE                  P          1  ORBIT                         2            4
CREATE EARTH SITE DEFINITION FILE                  U          0  ORBIT                         2            2
GENERATE ACQ/LOSS OF GROUND SITE TARGET AREAS      B          0  ORBIT                         2            1
GENERATE ACQ/LOSS OF GROUND SITE TARGET AREAS      P          0  ORBIT                         2            1
GENERATE ACQ/LOSS OF GROUND SITE TARGET AREAS      R          0  ORBIT                         2            1
GENERATE ACQ/LOSS OF GROUND SITE TARGET AREAS      U          0  ORBIT                         2            1
DEVELOP/APPLY CONSTRAINTS TO EARTH                 B          0  ORBIT                         2            1
OBSERVATION TARGETS
DEVELOP/APPLY CONSTRAINTS TO EARTH                 P          0  ORBIT                         2            1
OBSERVATION TARGETS
DEVELOP/APPLY CONSTRAINTS TO EARTH                 R          0  ORBIT                         2            1
OBSERVATION TARGETS
DEVELOP/APPLY CONSTRAINTS TO EARTH                 U          0  ORBIT                         2            1
OBSERVATION TARGETS
..............................................................................................................
```

```
                                        ACTIVITY TIME AND SKILL REQUIREMENTS                         DATE 04/08/87

                                                                                                     PAGE        5

                                                           CALENDAR                    SKILL LEVEL       MANPOWER
ACTIVITY                                           CYCLE  TIME(DAYS)   SKILL TYPE   (1-NOV,2-PRO,3-EXP)  (MAN-HOURS)
-------------------------------------------------  -----  ----------  ------------  -------------------  ----------
COMBINE CONSTRAINTS TO DETERMINE EARTH               B            0   ORBIT                        2            1
OBSERVATION TARGETS
COMBINE CONSTRAINTS TO DETERMINE EARTH               P            0   ORBIT                        2            1
OBSERVATION TARGETS
COMBINE CONSTRAINTS TO DETERMINE EARTH               R            0   ORBIT                        2            1
OBSERVATION TARGETS
COMBINE CONSTRAINTS TO DETERMINE EARTH               U            0   ORBIT                        2            1
OBSERVATION TARGETS
COMPUTE ORIENTATION AND STRENGTH OF MAGNETIC         B            1   ORBIT                        2            4
FIELD IN THE ORBITER COORDINATE SYSTEM
COMPUTE ORIENTATION AND STRENGTH OF MAGNETIC         P            1   ORBIT                        2            4
FIELD IN THE ORBITER COORDINATE SYSTEM
COMPUTE ORIENTATION AND STRENGTH OF MAGNETIC         R            0   ORBIT                        2            1
FIELD IN THE ORBITER COORDINATE SYSTEM
COMPUTE ORIENTATION AND STRENGTH OF MAGNETIC         U            1   ORBIT                        2            4
FIELD IN THE ORBITER COORDINATE SYSTEM
DEVELOP/APPLY CONSTRAINTS TO BORB PARAMETERS         B            0   ORBIT                        2            1
DEVELOP/APPLY CONSTRAINTS TO BORB PARAMETERS         P            0   ORBIT                        2            1
DEVELOP/APPLY CONSTRAINTS TO BORB PARAMETERS         R            0   ORBIT                        2            1
DEVELOP/APPLY CONSTRAINTS TO BORB PARAMETERS         U            0   ORBIT                        2            1
GENERATE HEMISPHERE OPPORTUNITIES                    B            0   ORBIT                        1            1
GENERATE HEMISPHERE OPPORTUNITIES                    P            0   ORBIT                        1            1
GENERATE HEMISPHERE OPPORTUNITIES                    R            0   ORBIT                        1            1
GENERATE HEMISPHERE OPPORTUNITIES                    U            0   ORBIT                        1            1
COMBINE CONSTRAINTS TO DETERMINE PLASMA              B            0   ORBIT                        2            2
PHYSICS TARGETS
COMBINE CONSTRAINTS TO DETERMINE PLASMA              P            1   ORBIT                        2            4
PHYSICS TARGETS
COMBINE CONSTRAINTS TO DETERMINE PLASMA              R            0   ORBIT                        2            1
PHYSICS TARGETS
COMBINE CONSTRAINTS TO DETERMINE PLASMA              U            0   ORBIT                        2            1
PHYSICS TARGETS
MERGE ALL EXPERIMENT TARGET FILES                    B            0   ORBIT                        1            1
MERGE ALL EXPERIMENT TARGET FILES                    P            0   ORBIT                        1            1
MERGE ALL EXPERIMENT TARGET FILES                    R            0   ORBIT                        1            1
-------------------------------------------------------------------------------------------------------------------
```

```
                              ACTIVITY TIME AND SKILL REQUIREMENTS                DATE 04/08/87

                                                                                  PAGE        6

                                                           CALENDAR                      SKILL LEVEL       MANPOWER
ACTIVITY                                           CYCLE  TIME(DAYS)   SKILL TYPE   (1-NOV,2-PRO,3-EXP)  (MAN-HOURS)
-------------------------------------------------  -----  ----------   ----------   -------------------  -----------
MERGE ALL EXPERIMENT TARGET FILES                    U            0    ORBIT                          1            1
PERFORM PARAMETRIC ANALYSIS TO DESIGN/DEVELOP        B            5    ORBIT                          3           40
CO-ORBITING TRAJECTORIES THAT SATISFY
OBJECTIVES AND CONSTRAINTS
PERFORM PARAMETRIC ANALYSIS TO DESIGN/DEVELOP        P            5    ORBIT                          3           40
CO-ORBITING TRAJECTORIES THAT SATISFY
OBJECTIVES AND CONSTRAINTS
PERFORM PARAMETRIC ANALYSIS TO DESIGN/DEVELOP        U            5    ORBIT                          3           40
CO-ORBITING TRAJECTORIES THAT SATISFY
OBJECTIVES AND CONSTRAINTS
DEVELOP GROSS MISSION TIMELINE                       B            2    ORBIT                          3           40
DEVELOP GROSS MISSION TIMELINE                       P            2    ORBIT                          2           40
DEVELOP GROSS MISSION TIMELINE                       U            1    ORBIT                          3            8
DEVELOP PRELIMINARY ATTITUDE TIMELINE                B            1    ORBIT                          3            8
DEVELOP PRELIMINARY ATTITUDE TIMELINE                P            1    ORBIT                          3            8
DEVELOP PRELIMINARY ATTITUDE TIMELINE                U            1    ORBIT                          3            4
CREATE COMMON FILE FOR ASTAR PROGRAM (DS)            B            1    ORBIT                          3            4
CREATE COMMON FILE FOR ASTAR PROGRAM (DS)            P            1    ORBIT                          3            4
CREATE COMMON FILE FOR ASTAR PROGRAM (DS)            U            1    ORBIT                          3            4
CREATE RESERVE PERIOD FILE (DS)                      B           10    ORBIT                          3           40
CREATE RESERVE PERIOD FILE (DS)                      P           10    ORBIT                          3           40
CREATE RESERVE PERIOD FILE (DS)                      U           10    ORBIT                          3           20
SCHEDULE SCIENCE OBSERVATIONS (DS)                   B            5    ORBIT                          3           40
SCHEDULE SCIENCE OBSERVATIONS (DS)                   P            5    ORBIT                          3           40
SCHEDULE SCIENCE OBSERVATIONS (DS)                   R            1    ORBIT                          3            8
SCHEDULE SCIENCE OBSERVATIONS (DS)                   U            5    ORBIT                          3           40
GENERATE ATTITUDE TIMELINE                           B            1    ORBIT                          3            8
GENERATE ATTITUDE TIMELINE                           P            1    ORBIT                          3            8
GENERATE ATTITUDE TIMELINE                           R            0    ORBIT                          3            4
GENERATE ATTITUDE TIMELINE                           U            0    ORBIT                          3            8
EDIT CURRENT ATTITUDE T/L TO INCORPORATE STS         B            1    ORBIT                          3            1
OR OTHER REQMTS
EDIT CURRENT ATTITUDE T/L TO INCORPORATE STS         P            1    ORBIT                          3            1
OR OTHER REQMTS
------------------------------------------------------------------------------------------------------------------
```

ACTIVITY	CYCLE	CALENDAR TIME(DAYS)	SKILL TYPE	SKILL LEVEL (1-NOV,2-PRO,3-EXP)	MANPOWER (MAN-HOURS)
EDIT CURRENT ATTITUDE T/L TO INCORPORATE STS OR OTHER REQMTS	R	0	ORBIT	3	1
EDIT CURRENT ATTITUDE T/L TO INCORPORATE STS OR OTHER REQMTS	U	0	ORBIT	3	1
GENERATE MANEUVER TIMELINE (DS)	B	1	ORBIT	3	8
GENERATE MANEUVER TIMELINE (DS)	P	1	ORBIT	3	8
GENERATE MANEUVER TIMELINE (DS)	R	0	ORBIT	3	1
GENERATE MANEUVER TIMELINE (DS)	U	1	ORBIT	3	4
GENERATE ATTITUDE TIMELINE (DS)	B	1	ORBIT	3	4
GENERATE ATTITUDE TIMELINE (DS)	P	1	ORBIT	3	4
GENERATE ATTITUDE TIMELINE (DS)	R	0	ORBIT	3	2
GENERATE ATTITUDE TIMELINE (DS)	U	1	ORBIT	3	4
EDIT TO INCORPORATE STS OR OTHER REQMTS (DS)	B	0	ORBIT	2	2
EDIT TO INCORPORATE STS OR OTHER REQMTS (DS)	P	0	ORBIT	2	2
EDIT TO INCORPORATE STS OR OTHER REQMTS (DS)	R	0	ORBIT	2	1
EDIT TO INCORPORATE STS OR OTHER REQMTS (DS)	U	0	ORBIT	2	1
GENERATE ORBITER POINTING DATA	B	0	ORBIT	2	1
GENERATE ORBITER POINTING DATA	P	0	ORBIT	2	1
GENERATE ORBITER POINTING DATA	R	0	ORBIT	2	1
GENERATE ORBITER POINTING DATA	U	0	ORBIT	2	1
GENERATE TDRS COVERAGE	B	1	ORBIT	3	1
GENERATE TDRS COVERAGE	P	1	ORBIT	3	1
GENERATE TDRS COVERAGE	R	0	ORBIT	3	1
GENERATE TDRS COVERAGE	U	1	ORBIT	3	1
PROCESS TDRS DATA FOR ENHANCEMENT	B	0	ORBIT	3	1
PROCESS TDRS DATA FOR ENHANCEMENT	P	0	ORBIT	3	1
PROCESS TDRS DATA FOR ENHANCEMENT	R	0	ORBIT	3	1
PROCESS TDRS DATA FOR ENHANCEMENT	U	0	ORBIT	3	1
GENERATE POCC MMU DATA SET	B	0	ORBIT	2	1
GENERATE POCC MMU DATA SET	P	0	ORBIT	2	1
GENERATE POCC MMU DATA SET	R	0	ORBIT	2	1
GENERATE POCC MMU DATA SET	U	0	ORBIT	2	1
GENERATE CANDIDATE SOLAR GUIDE STARS	B	5	ORBIT	3	40
GENERATE CANDIDATE SOLAR GUIDE STARS	P	5	ORBIT	3	40
GENERATE CANDIDATE SOLAR GUIDE STARS	U	2	ORBIT	3	16

ACTIVITY TIME AND SKILL REQUIREMENTS

ACTIVITY	CYCLE	CALENDAR TIME(DAYS)	SKILL TYPE	SKILL LEVEL (1-NOV,2-PRO,3-EXP)	MANPOWER (MAN-HOURS)
DEVELOP STRAY LIGHT CONSTRAINTS	B	5	ORBIT	3	40
DEVELOP STRAY LIGHT CONSTRAINTS	P	1	ORBIT	3	4
DEVELOP STRAY LIGHT CONSTRAINTS	U	2	ORBIT	3	16
CHOOSE SOLAR GUIDE STARS	B	5	ORBIT	3	40
CHOOSE SOLAR GUIDE STARS	P	5	ORBIT	3	40
CHOOSE SOLAR GUIDE STARS	U	5	ORBIT	3	40
GENERATE SOLAR OBJECTIVE LOADS	B	5	ORBIT	3	40
GENERATE SOLAR OBJECTIVE LOADS	P	5	ORBIT	3	40
GENERATE SOLAR OBJECTIVE LOADS	U	3	ORBIT	3	20
GENERATE CANDIDATE STELLAR GUIDE STARS (DS)	B	5	ORBIT	3	40
GENERATE CANDIDATE STELLAR GUIDE STARS (DS)	P	5	ORBIT	3	40
GENERATE CANDIDATE STELLAR GUIDE STARS (DS)	U	3	ORBIT	3	20
FORMAT STELLAR GUIDE STAR CATALOG (DS)	B	0	ORBIT	3	2
FORMAT STELLAR GUIDE STAR CATALOG (DS)	P	0	ORBIT	3	2
FORMAT STELLAR GUIDE STAR CATALOG (DS)	U	0	ORBIT	3	2
SELECT IPS ROLL ANGLES (DS)	B	1	ORBIT	3	4
SELECT IPS ROLL ANGLES (DS)	P	1	ORBIT	3	4
SELECT IPS ROLL ANGLES (DS)	U	1	ORBIT	3	4
GENERATE STELLAR OBJECTIVE LOADS (DS)	B	5	ORBIT	3	40
GENERATE STELLAR OBJECTIVE LOADS (DS)	P	5	ORBIT	3	40
GENERATE STELLAR OBJECTIVE LOADS (DS)	U	3	ORBIT	3	20
GENERATE IPS POINTING DATA (DS)	B	0	ORBIT	3	2
GENERATE IPS POINTING DATA (DS)	P	0	ORBIT	3	2
GENERATE IPS POINTING DATA (DS)	R	0	ORBIT	3	1
GENFRATE IPS POINTING DATA (DS)	U	0	ORBIT	3	2
PI EDITS TO ADD SEQUENCE NUMBER (DS)	B	5	ORBIT	2	8
PI EDITS TO ADD SEQUENCE NUMBER (DS)	P	5	ORBIT	2	8
PI EDITS TO ADD SEQUENCE NUMBER (DS)	U	5	ORBIT	2	8
GENERATE JOINT OPERATIONS TARGET FILE (DS)	B	1	ORBIT	3	4
GENERATE JOINT OPERATIONS TARGET FILE (DS)	P	1	ORBIT	3	4
GENERATE JOINT OPERATIONS TARGET FILE (DS)	R	0	ORBIT	3	1
GENERATE JOINT OPERATIONS TARGET FILE (DS)	U	1	ORBIT	3	4
CREATE MISSION TIMELINE MODELS	B	21	TIMELINE	3	240
CREATE MISSION TIMELINE MODELS	P	21	TIMELINE	3	240
CREATE MISSION TIMELINE MODELS	U	14	TIMELINE	3	160

ACTIVITY TIME AND SKILL REQUIREMENTS

ACTIVITY	CYCLE	CALENDAR TIME(DAYS)	SKILL TYPE	SKILL LEVEL (1-NOV,2-PRO,3-EXP)	MANPOWER (MAN-HOURS)
GENERATE CREW H/O CYCLE	B	3	TIMELINE	2	24
GENERATE CREW H/O CYCLE	P	3	TIMELINE	2	24
GENERATE CREW H/O CYCLE	R	0	TIMELINE	2	2
GENERATE CREW H/O CYCLE	U	3	TIMELINE	2	24
CREATE ESS TARGET FILE	B	2	TIMELINE	2	12
CREATE ESS TARGET FILE	P	3	TIMELINE	2	20
CREATE ESS TARGET FILE	R	0	TIMELINE	2	1
CREATE ESS TARGET FILE	U	2	TIMELINE	2	12
GENERATE MISSION TIMELINE	B	25	TIMELINE	2	600
GENERATE MISSION TIMELINE	P	20	TIMELINE	2	480
GENERATE MISSION TIMELINE	R	1	TIMELINE	3	6
GENERATE MISSION TIMELINE	U	20	TIMELINE	2	640
FINALIZE MISSION TIMELINE	B	5	TIMELINE	2	120
FINALIZE MISSION TIMELINE	P	5	TIMELINE	2	120
FINALIZE MISSION TIMELINE	R	0	TIMELINE	3	2
FINALIZE MISSION TIMELINE	U	5	TIMELINE	2	160
GENERATE PCAP CHARTS	B	25	TIMELINE	3	400
GENERATE PCAP CHARTS	R	0	TIMELINE	3	2
GENERATE PCAP CHARTS	U	30	TIMELINE	3	720
GENERATE PTS CHARTS	B	5	TIMELINE	2	40
GENERATE PTS CHARTS	P	5	TIMELINE	2	40
GENERATE PTS CHARTS	R	0	TIMELINE	2	1
GENERATE PTS CHARTS	U	5	TIMELINE	2	40
BUILD PCAP DOCUMENT	B	5	TIMELINE	2	80
BUILD PCAP DOCUMENT	R	0	TIMELINE	2	1
BUILD PCAP DOCUMENT	U	5	TIMELINE	3	120
FLIGHT DEFINITION DOCUMENT DEVELOPMENT	B	14	FDD DEVELOP	2	168
FLIGHT DEFINITION DOCUMENT DEVELOPMENT	P	14	FDD DEVELOP	2	168
FLIGHT DEFINITION DOCUMENT DEVELOPMENT	U	14	FDD DEVELOP	2	168
FLIGHT PLANNING ANNEX INPUT DEVELOPMENT	B	14	FPA DEVELOP	2	168
FLIGHT PLANNING ANNEX INPUT DEVELOPMENT	P	14	FPA DEVELOP	2	168
FLIGHT PLANNING ANNEX INPUT DEVELOPMENT	U	14	FPA DEVELOP	2	168
DEVELOP STOWAGE BOOK	B	210	CREW PRO DEV	2	360
DEVELOP STOWAGE BOOK	P	90	CREW PRO DEV	2	155
DEVELOP STOWAGE BOOK	U	120	CREW PRO DEV	2	206

```
                              ACTIVITY TIME AND SKILL REQUIREMENTS                 DATE 04/08/87

                                                                                   PAGE       10

                                                     CALENDAR                         SKILL LEVEL         MANPOWER
ACTIVITY                                    CYCLE   TIME(DAYS)   SKILL TYPE      (1-NOV,2-PRO,3-EXP)    (MAN-HOURS)
------------------------------------------  -----   ----------   ------------    -------------------    -----------
DEVELOP TV, PHOTO PROCEDURES                  B          210     CREW PRO DEV                     2            1200
DEVELOP TV, PHOTO PROCEDURES                  P           90     CREW PRO DEV                     2             514
DEVELOP TV, PHOTO PROCEDURES                  U          120     CREW PRO DEV                     2             686
DEVELOP EXPERIMENT CREW PROCEDURES            B          210     CREW PRO DEV                     2            3600
DEVELOP EXPERIMENT CREW PROCEDURES            P           90     CREW PRO DEV                     2            1543
DEVELOP EXPERIMENT CREW PROCEDURES            U          120     CREW PRO DEV                     2             686
DEVELOP PAYLOAD SYSTEMS HANDBOOK              B          210     CREW PRO DEV                     2             720
DEVELOP PAYLOAD SYSTEMS HANDBOOK              P           90     CREW PRO DEV                     2             309
DEVELOP PAYLOAD SYSTEMS HANDBOOK              U          120     CREW PRO DEV                     2             411
DEVELOP CDMS DICTIONARY                       B          210     CREW PRO DEV                     2             240
DEVELOP CDMS DICTIONARY                       P           90     CREW PRO DEV                     2             103
DEVELOP CDMS DICTIONARY                       U          120     CREW PRO DEV                     2             137
BUILD PFDF DOCUMENTS                          B           21     CREW PRO DEV                     2             240
BUILD PFDF DOCUMENTS                          P           21     CREW PRO DEV                     2             240
BUILD PFDF DOCUMENTS                          U           21     CREW PRO DEV                     2             240
CREATE DATA FLOW MODELS                       B           10     DATA                             3              40
CREATE DATA FLOW MODELS                       P           90     DATA                             3             100
CREATE DATA FLOW MODELS                       U            2     DATA                             3              10
GENERATE MISSION DATA REQUIREMENTS PROFILE    B           10     DATA                             3              40
GENERATE MISSION DATA REQUIREMENTS PROFILE    P           90     DATA                             3             100
GENERATE MISSION DATA REQUIREMENTS PROFILE    R            1     DATA                             3               1
GENERATE MISSION DATA REQUIREMENTS PROFILE    U            3     DATA                             3              20
GENERATE MISSION WINDOWS                      B            3     DATA                             3              10
GENERATE MISSION WINDOWS                      P           10     DATA                             3              50
GENERATE MISSION WINDOWS                      R            1     DATA                             3               1
GENERATE MISSION WINDOWS                      U            1     DATA                             3               5
SCHEDULE ONBOARD RECORDER OPERATIONS          B            1     DATA                             2               5
SCHEDULE ONBOARD RECORDER OPERATIONS          P            3     DATA                             2              20
SCHEDULE ONBOARD RECORDER OPERATIONS          R            1     DATA                             2               1
SCHEDULE ONBOARD RECORDER OPERATIONS          U            1     DATA                             2               2
GENERATE HRM POSSIBLE FORMATS                 B            2     DATA                             2              10
GENERATE HRM POSSIBLE FORMATS                 P            1     DATA                             2               5
GENERATE HRM POSSIBLE FORMATS                 U            1     DATA                             2               2
SCHEDULE HRM FORMATS AND DOWNLINK             B            1     DATA                             2               5
SCHEDULE HRM FORMATS AND DOWNLINK             P            3     DATA                             2              20
--------------------------------------------------------------------------------------------------------------------
```

```
                              ACTIVITY TIME AND SKILL REQUIREMENTS                   DATE 04/08/87

                                                                                     PAGE        11

                                                      CALENDAR                          SKILL LEVEL       MANPOWER
ACTIVITY                                       CYCLE  TIME(DAYS)  SKILL TYPE   (1-NOV,2-PRO,3-EXP)  (MAN-HOURS)
---------------------------------------------  -----  ----------  -----------  -------------------  -----------
SCHEDULE HRM FORMATS AND DOWNLINK                R             1  DATA                           2            1
SCHEDULE HRM FORMATS AND DOWNLINK                U             1  DATA                           2            2
GENERATE POCC POSSIBLE CONFIGURATIONS            B             1  DATA                           2            5
GENERATE POCC POSSIBLE CONFIGURATIONS            P             1  DATA                           2            5
GENERATE POCC POSSIBLE CONFIGURATIONS            U             1  DATA                           2            1
SCHEDULE POCC CONFIGURATIONS                     B             1  DATA                           2            2
SCHEDULE POCC CONFIGURATIONS                     P             2  DATA                           2           10
SCHEDULE POCC CONFIGURATIONS                     R             1  DATA                           2            1
SCHEDULE POCC CONFIGURATIONS                     U             1  DATA                           2            1
SCHEDULE RECORDER PLAYBACKS                      B             1  DATA                           3            5
SCHEDULE RECORDER PLAYBACKS                      P             3  DATA                           3           20
SCHEDULE RECORDER PLAYBACKS                      R             1  DATA                           3            1
SCHEDULE RECORDER PLAYBACKS                      U             1  DATA                           3            2
VERIFY DATA FLOW SCHEDULES                       B             3  DATA                           3           20
VERIFY DATA FLOW SCHEDULES                       R             1  DATA                           3            1
VERIFY DATA FLOW SCHEDULES                       U             3  DATA                           3           20
GENERATE DATA FLOW REPORTS                       B             5  DATA                           3           20
GENERATE DATA FLOW REPORTS                       P             3  DATA                           3           10
GENERATE DATA FLOW REPORTS                       R             1  DATA                           3            1
GENERATE DATA FLOW REPORTS                       U             1  DATA                           3            5
UPDATE OR ENHANCE EXISTING SCHEDULES             B             5  DATA                           3           40
UPDATE OR ENHANCE EXISTING SCHEDULES             R             1  DATA                           3            1
UPDATE OR ENHANCE EXISTING SCHEDULES             U             2  DATA                           3           10
CREATE SUBORDINATE TIMELINES                     B            60  MMU                            2          320
CHECK STL SYNTAX                                 B             5  MMU                            2           40
DESKTOP STL OPERATIONAL VERIFICATION             B             5  MMU                            2           60
CREATE MASTER INPUT FILES                        B            30  MMU                            2          100
VERIFY AND COMBINE MASTER INPUT FILES            B             1  MMU                            2           40
GENERATE MASTER TIMELINE                         B             1  MMU                            2            4
VERIFY MASTER TIMELINE                           B             1  MMU                            2            8
GENERATE STL BUFFER UTILIZATION REPORT           B             7  MMU                            2           40
DESKTOP MTL OPERATIONAL VERIFICATION             B             7  MMU                            2          120
CONVERT TO IBM TAPE FORMAT AND VERIFY            B             2  MMU                            2            6
GENERATE ECOS TIMELINE DOCUMENT                  B             4  MMU                            2            8
CREATE MMU ALLOCATION FILE                       B             3  MMU                            2           24
-------------------------------------------------------------------------------------------------------------------
```

```
                              ACTIVITY TIME AND SKILL REQUIREMENTS                     DATE 04/08/87

                                                                                       PAGE        12

                                                       CALENDAR                        SKILL LEVEL         MANPOWER
ACTIVITY                                        CYCLE  TIME(DAYS)  SKILL TYPE     (1-NOV,2-PRO,3-EXP)  (MAN-HOURS)
----------------------------------------------- -----  ----------  ------------   -------------------  -----------
EVALUATE MMU TAPE MOVEMENT                        B             3  MMU                             3           24
CREATE COMMAND LIST                               B            15  EXP CMD PLNG                    3          160
CREATE COMMAND LIST                               R             1  EXP CMD PLNG                    3            8
CREATE COMMAND LIST                               U             5  EXP CMD PLNG                    3           32
CHECK COMMAND SYNTAX                              B             1  EXP CMD PLNG                    2            4
CHECK COMMAND SYNTAX                              R             1  EXP CMD PLNG                    2            8
CHECK COMMAND SYNTAX                              U             1  EXP CMD PLNG                    2            4
PRODUCE COMMAND TIMETAGS                          B             1  EXP CMD PLNG                    2            4
PRODUCE COMMAND TIMETAGS                          R             1  EXP CMD PLNG                    2            8
PRODUCE COMMAND TIMETAGS                          U             1  EXP CMD PLNG                    2            4
GENERATE COMMAND TIMELINE                         B             3  EXP CMD PLNG                    2            8
GENERATE COMMAND TIMELINE                         R             1  EXP CMD PLNG                    2            8
GENERATE COMMAND TIMELINE                         U             3  EXP CMD PLNG                    2            8
CREATE POCC CHECKLIST                             B            10  EXP CMD PLNG                    3          160
CREATE POCC CHECKLIST                             R             1  EXP CMD PLNG                    3            8
CREATE POCC CHECKLIST                             U             5  EXP CMD PLNG                    3           32
CHECK ACTIVITY SYNTAX                             B             1  EXP CMD PLNG                    2            4
CHECK ACTIVITY SYNTAX                             R             1  EXP CMD PLNG                    2            8
CHECK ACTIVITY SYNTAX                             U             1  EXP CMD PLNG                    2            4
PRODUCE ACTIVITY TIMETAGS                         B             1  EXP CMD PLNG                    2            4
PRODUCE ACTIVITY TIMETAGS                         R             1  EXP CMD PLNG                    2            8
PRODUCE ACTIVITY TIMETAGS                         U             1  EXP CMD PLNG                    2            4
GENERATE POCC CHECKLIST AND COMMAND TIMELINE      B             3  EXP CMD PLNG                    2            8
GENERATE POCC CHECKLIST AND COMMAND TIMELINE      R             1  EXP CMD PLNG                    2            8
GENERATE POCC CHECKLIST AND COMMAND TIMELINE      U             3  EXP CMD PLNG                    2            8
-------------------------------------------------------------------------------------------------------------------
```

TABLE 3
SOFTWARE USED BY ACTIVITY

SOFTWARE USED BY ACTIVITY DATE 03/19/87

ACTIVITY NAME	SOFTWARE NAME	TIME REQUIRED FOR USE BY PLANNING CYCLE (HRS) PRELIMINARY	BASIC	UPDATE	REPLANNING
LAUNCH WINDOW/LAUNCH TIME SELECTION	LWAP	1	1	1	0
GENERATE STATE VECTOR	LANTIM	1	0	0	0
CONVERT/STORE STATE VECTOR	VECTOR	1	1	1	1
GENERATE ORBITAL EPHEMERIS BY NUMERICAL INTEGRATION	NSEP	2	2	2	1
GENERATE REQUIRED EPHEMERIS DATA FOR OUTPUT	ASEP-1	1	1	1	1
GENERATE EARTH SHADOW ACQ/LOSS	ASEP-2	1	1	1	1
GENERATE SUN RISE/SET	TARGEN	1	1	1	1
GENERATE MOON RISE/SET	STAR	1	1	1	1
GENERATE PRELIMINARY TDRS COVERAGE	CAVA/CAVINP	1	1	1	0
GENERATE GROUND STATION COVERAGE	SALES	1	1	1	1
GENERATE RADIATION ENVIRONMENT	RADI2	1	1	1	1
IMPOSE RADIATION CONSTRAINTS	LTO-1	1	1	1	1
MERGE MISSION INDEPENDENT TARGETS	TARGEN	1	1	1	1
DEVELOP CELESTIAL TARGETS (NON-IPS MISSIONS)	STAR-1	1	1	1	0
DEVELOP CELESTIAL TARGETS (IPS MISSIONS)	SUBCOO	1	1	1	0

ACTIVITY NAME	SOFTWARE NAME	TIME REQUIRED FOR USE BY PLANNING CYCLE (HRS) PRELIMINARY	BASIC	UPDATE	REPLANNING
GENERATE CELESTIAL TARGET(S) ACQ/LOSS	STAR-2	1	1	1	1
COMBINE CONSTRAINTS TO DETERMINE CELESTIAL TARGETS AND MERGE FILES	TARGEN	1	1	1	1
COMPUTE DISTANCE FROM TANGENT POINT ON THE ORBITER TO SUN LINE-OF-SIGHT TO THE EARTH SURFACE	TANRAY	1	1	1	1
DEVELOP/APPLY CONSTRAINTS TO ATMOSPHERIC PHYSICS OBSERVATION PERIODS	LTO-4	1	1	1	1
COMPUTE ORBIT TERMINATOR TARGETS	TARGEN	1	1	1	1
COMBINE CONSTRAINTS TO DETERMINE ATMOSPHERIC PHYSICS TARGETS	TARGEN	1	1	1	1
COMPUTE SUN AZIMUTH AND ELEVATION FROM ORBITING VEHICLE WITH RESPECT TO SUN RISE/SET EVENTS	ATMOS	0	0	0	1
DEVELOP CONSTRAINTS FOR SOLAR VIEWING PERIODS	LTO-1	1	1	1	1
COMBINE CONSTRAINTS TO DETERMINE SOLAR TARGETS	TARGEN	1	1	1	1
CREATE EARTH SITE DEFINITION FILE	ESDAT	2	2	2	0
GENERATE ACQ/LOSS OF GROUND SITE TARGET AREAS	ESAL	1	1	1	1
DEVELOP/APPLY CONSTRAINTS TO EARTH OBSERVATION TARGETS	LTO-3	1	1	1	1

ACTIVITY NAME	SOFTWARE NAME	TIME REQUIRED FOR USE BY PLANNING CYCLE (HRS) PRELIMINARY	BASIC	UPDATE	REPLANNING
COMBINE CONSTRAINTS TO DETERMINE EARTH OBSERVATION TARGETS	TARGEN	1	1	1	1
COMPUTE ORIENTATION AND STRENGTH OF MAGNETIC FIELD IN THE ORBITER COORDINATE SYSTEM	BORB	1	1	1	1
DEVELOP/APPLY CONSTRAINTS TO BORB PARAMETERS	LTO-2	1	1	1	1
GENERATE HEMISPHERE OPPORTUNITIES	LTO-1	1	1	1	1
COMBINE CONSTRAINTS TO DETERMINE PLASMA PHYSICS TARGETS	TARGEN	4	4	4	4
MERGE ALL EXPERIMENT TARGET FILES	TARGEN	1	1	1	1
PERFORM PARAMETRIC ANALYSIS TO DESIGN/DEVELOP CO-ORBITING TRAJECTORIES THAT SATISFY OBJECTIVES AND CONSTRAINTS	RELMO	10	10	10	0
DEVELOP PRELIMINARY ATTITUDE TIMELINE	CAVA/CAVINP	1	1	1	0
CREATE COMMON FILE FOR ASTAR PROGRAM (DS)	READPI	2	2	2	0
CREATE RESERVE PERIOD FILE (DS)	EDT	8	8	4	0
SCHEDULE SCIENCE OBSERVATIONS (DS)	ASTAR	80	80	80	5
GENERATE ATTITUDE TIMELINE	CAVA/KEYGEN	8	8	8	1
EDIT CURRENT ATTITUDE T/L TO INCORPORATE STS OR OTHER REQMTS	CAVA/CAVINP	1	1	1	0

SOFTWARE USED BY ACTIVITY

ACTIVITY NAME	SOFTWARE NAME	TIME REQUIRED FOR USE BY PLANNING CYCLE (HRS) PRELIMINARY	BASIC	UPDATE	REPLANNING
GENERATE MANEUVER TIMELINE (DS)	PAAC	4	4	4	1
GENERATE ATTITUDE TIMELINE (DS)	CAVA/KEYGEN	4	4	4	1
EDIT TO INCORPORATE STS OR OTHER REQNTS (DS)	CAVA/CAVINP	1	1	1	0
GENERATE ORBITER POINTING DATA	PROCAM	1	1	1	1
GENERATE TDRS COVERAGE	CAVA/CAVINP	1	1	1	1
PROCESS TDRS DATA FOR ENHANCEMENT	TARGEN	1	1	1	1
GENERATE POCC MMU DATA SET	PMDSG	1	1	1	1
GENERATE CANDIDATE SOLAR GUIDE STARS	SCATGEN	40	40	40	0
DEVELOP STRAY LIGHT CONSTRAINTS	ASTRO	0	8	8	0
GENERATE SOLAR OBJECTIVE LOADS	SCATGEN	40	40	40	0
GENERATE CANDIDATE STELLAR GUIDE STARS (DS)	GSOLP-1	40	40	40	0
FORMAT STELLAR GUIDE STAR CATALOG (DS)	GSOLP-2	2	2	2	0
SELECT IPS ROLL ANGLES (DS)	GIMBAL	4	4	4	0
GENERATE STELLAR OBJECTIVE LOADS (DS)	GSOLP-2	40	40	40	0
GENERATE IPS POINTING DATA (DS)	IPOL	2	2	2	2
PI EDITS TO ADD SEQUENCE NUMBER (DS)	EDT	2	2	2	0

SOFTWARE USED BY ACTIVITY DATE 03/19/87

ACTIVITY NAME	SOFTWARE NAME	TIME REQUIRED FOR USE BY PLANNING CYCLE (HRS) PRELIMINARY	BASIC	UPDATE	REPLANNING
GENERATE JOINT OPERATIONS TARGET FILE (DS)	JOTF	4	4	4	4
CREATE MISSION TIMELINE MODELS	VME	108	108	108	1
CREATE ESS TARGET FILE	TAE	10	10	10	1
GENERATE MISSION TIMELINE	ESP	128	160	128	4
FINALIZE MISSION TIMELINE	ESP	0	32	32	2
GENERATE PCAP CHARTS	PCAP	0	160	192	2
GENERATE PTS CHARTS	PTS	24	24	24	1
CREATE DATA FLOW MODELS	EDT	15	5	1	0
GENERATE MISSION DATA REQUIREMENTS PROFILE	DF/MDRPG	50	20	10	1
GENERATE MISSION WINDOWS	DF/MWG	40	8	4	1
SCHEDULE ONBOARD RECORDER OPERATIONS	DF/ORS	16	4	1	1
GENERATE HRM POSSIBLE FORMATS	DF/HPFG	4	8	2	0
SCHEDULE HRM FORMATS AND DOWNLINK	DF/HFS	16	4	1	1
GENERATE POCC POSSIBLE CUNFIGURATIONS	DF/PPCG	4	4	1	0
SCHEDULE POCC CONFIGURATIONS	DF/PCS	8	1	1	1
SCHEDULE RECORDER PLAYBACKS	DF/PBS	16	4	1	1

SOFTWARE USED BY ACTIVITY DATE 03/19/87

ACTIVITY NAME	SOFTWARE NAME	TIME REQUIRED FOR USE BY PLANNING CYCLE (HRS) PRELIMINARY	BASIC	UPDATE	REPLANNING
VERIFY DATA FLOW SCHEDULES	DF/DVM	0	16	16	1
GENERATE DATA FLOW REPORTS	DF/DFRG	5	10	3	1
UPDATE OR ENHANCE EXISTING SCHEDULES	IDUS	0	40	10	1
CREATE SUBORDINATE TIMELINES	EDT	0	320	0	0
CHECK STL SYNTAX	VERSTL	0	40	0	0
CREATE MASTER INPUT FILES	EDT	0	160	0	0
VERIFY AND COMBINE MASTER INPUT FILES	VERMI	0	40	0	0
GENERATE MASTER TIMELINE	GENMTL	0	8	0	0
VERIFY MASTER TIMELINE	VERMTL	0	8	0	0
GENERATE STL BUFFER UTILIZATION REPORT	STLBUF	0	40	0	0
CONVERT TO IBM TAPE FORMAT AND VERIFY	DEL.COM	0	16	0	0
CREATE MMU ALLOCATION FILE	EDT	0	24	0	0
EVALUATE MMU TAPE MOVEMENT	MMUALL	0	8	0	0
CREATE COMMAND LIST	EDT	0	120	40	4
CHECK COMMAND SYNTAX	CHECK	0	8	8	4
PRODUCE COMMAND TIMETAGS	MET	0	8	8	4
GENERATE COMMAND TIMELINE	CMDATG	0	24	24	8

SOFTWARE USED BY ACTIVITY DATE 03/19/87

ACTIVITY NAME	SOFTWARE NAME	TIME REQUIRED FOR USE BY PLANNING CYCLE (HRS) PRELIMINARY	BASIC	UPDATE	REPLANNING
CREATE POCC CHECKLIST	EDT	0	80	40	4
CHECK ACTIVITY SYNTAX	CHECK	0	8	8	4
PRODUCE ACTIVITY TIMETAGS	NET	0	8	8	4
GENERATE POCC CHECKLIST AND COMMAND TIMELINE	CG	0	24	24	8

TABLE 4
SOFTWARE DESCRIPTION

```
                                                     SOFTWARE DESCRIPTION                       DATE 03/17/87

                                                                                                PAGE        1

                                                                 SKILL REQMTS                    MEMORY   RUNTIME
SW NAME    SW FUNCTION                           MODE OF USE     TYPE       LEVEL     LANGUAGE    LINES    (BYTES)    (MIN)
---------- ------------------------------------ ------------ ---------- ---------- ---------- ---------- ---------- ---------
ASEP-1     (ANALYTIC SATELLITE EPHEMERIS         INTERACTIVE  ORBIT      PROFICIENT FORTRAN         14191    1474000       110
           PROGRAM)  THIS PROGRAM COMPUTES
           (ANALYTICALLY) AN EARTH SATELLITE
           EMPHEMERIS.  THE PROGRAM CONSISTS OF
           SEVERAL COMPUTATIONAL OPTIONS:  1) A
           DETAILED TRAJECTORY CONSISTING OF A
           TIME HISTORY (ANY DELTA TIME) OF 110
           VARIABLES, 2) A GROUND TRACK
           TRAJECTORY CONSISTING OF A TIME
           HISTORY OF THE LATITUDE AND
           LONGITUDE OF THE SATELLITE SUB-POINT
           AND 10 OTHER VARIABLES, 3) EARTH
           SHADOW ACQUISITION AND LOSS
           COMPUTATION, 4) A LAUNCH TIME
           PARAMETERIZATION WHERE MULTIPLE
           DETAILED TRAJECTORIES ARE GENERATED
           FOR A USER SPECIFIED RANGE OF LAUNCH
           TIMES AND, 5) THE CAPABILITY TO
           DRIVE THOSE ABOVE OPTIONS WITH AN
           EPHEMERIS FILE GENERATED BY NSEP.

--------------------------------------------------------------------------------------------------------------------------
```

SW NAME	SW FUNCTION	MODE OF USE	SKILL REQMTS TYPE	SKILL REQMTS LEVEL	LANGUAGE	LINES	MEMORY (BYTES)	RUNTIME (MIN)
ASEP-2	(ANALYTIC SATELLITE EPHEMERIS PROGRAM) THIS PROGRAM COMPUTES (ANALYTICALLY) AN EARTH SATELLITE EMPHEMERIS. THE PROGRAM CONSISTS OF SEVERAL COMPUTATIONAL OPTIONS: 1) A DETAILED TRAJECTORY CONSISTING OF A TIME HISTORY (ANY DELTA TIME) OF 110 VARIABLES, 2) A GROUND TRACK TRAJECTORY CONSISTING OF A TIME HISTORY OF THE LATITUDE AND LONGITUDE OF THE SATELLITE SUB-POINT AND 10 OTHER VARIABLES, 3) EARTH SHADOW ACQUISITION AND LOSS COMPUTATION, 4) A LAUNCH TIME PARAMETERIZATION WHERE MULTIPLE DETAILED TRAJECTORIES ARE GENERATED FOR A USER SPECIFIED RANGE OF LAUNCH TIMES AND, 5) THE CAPABILITY TO DRIVE THOSE ABOVE OPTIONS WITH AN EPHEMERIS FILE GENERATED BY NSEP.	INTERACTIVE	ORBIT	PROFICIENT	FORTRAN	14191	1474000	20

			SKILL REQMTS				MEMORY	RUNTIME
SW NAME	SW FUNCTION	MODE OF USE	TYPE	LEVEL	LANGUAGE	LINES	(BYTES)	(MIN)
ASTAR	(ASTRONOMY SCHEDULER) THIS PROGRAM IS DESIGNED TO PRODUCE A VIEWING SCHEDULE FOR SPACE SHUTTLE BASED ASTRONOMY MISSIONS. IT EMPLOYS AN AUTOMATED SCHEDULING ALGORITHM TO GENERATE OBSERVATION SEQUENCES THAT MAKE EFFICIENT USE OF AVAILABLE OBSERVATORY TIME. FACTORS INCLUDE PRIORITY, WINDOWS, SLEW TIMES, VIEWING CONSTRAINTS, AND RESERVED PERIODS. OUTPUT INCLUDES VIEWING SCHEDULE, STATISTICS, GRAPHS AND FILES FOR INPUT TO THE CREW TIMELINE AND ORBITER ATTITUDE PROGRAMS.	INTERACTIVE	ORBIT	PROFICIENT	FORTRAN	11000	5431000	15
ASTRO	THIS PROGRAM IS DESIGNED TO PROVIDE THE CAPABILITIES FOR ENTERING ASTRONOMY DATA WITH SPECIFIED FIELDS OF VIEWS (FOW), VIEWING AVAILABILITY ON THE CELESTIAL SPHERE, AND PLOTTING THE DATA. THE CELESTIAL SPHERE IS REPRESENTED BY A RECTANGULAR GRID OF RIGHT ASCENSION(S) AND DECLINATION(S). THE SUN, MOON, PLANETS AND STELLAR TARGETS MAY BE VIEWED GRAPHICALLY IN VARIOUS PLANES AND FOV'S. THE INPUT IS VIA DATA FILES OR A CROSS-HAIR EDITOR. OUTPUT IS VIA A DATA FILE AND THE TERMINAL.	INTERACTIVE	ORBIT	PROFICIENT	FORTRAN	5410	1232	60

```
                                                                  SKILL REQMTS                                     MEMORY     RUNTIME
SW NAME    SW FUNCTION                          MODE OF USE    TYPE       LEVEL       LANGUAGE       LINES     (BYTES)      (MIN)
---------  -----------------------------------  -----------    ---------  ----------  ----------  ----------  ----------  ---------
ATMOS      (ATMOS EXPERIMENT PROGRAM)  THIS     INTERACTIVE    ORBIT      PROFICIENT  FORTRAN           1650     1525000         10
           PROGRAM DOES CALCULATIONS OF THE
           AZIMUTH AND ELEVATION OF THE SUN AS
           SEEN FROM THE VEHICLE AT USER
           SPECIFIED TIMES WITH RESPECT TO SUN
           RISE AND SET EVENTS.  THE PROGRAM
           REQUIRES A NODE FILE AND A
           SPECIFICATION OF THE ATTITUDE AS
           INPUT.  OUTPUT IS A TABLE OF SUN
           AZIMUTHS AND ELEVATIONS OR A
           LIST-DIRECTED FILE CONTAINING THAT
           INFORMATION.

BORB       (B-VECTOR IN THE ORBITER COORDINATE  INTERACTIVE    ORBIT      PROFICIENT  FORTRAN           2100     1263000         45
           SYSTEM)  THIS PROGRAM COMPUTES THE
           STRENTGTH OF THE GEOMAGNETIC FIELD
           AND THE DIRECTIONS OF THIS FIELD AT
           THE CURRENT POSITION OF THE ORBITER
           IN SEVERAL COORDINATE SYSTEMS
           INCLUDING THE ORBITER BODY SYSTEM.
           THE PROGRAM CONTAINS THE OPTION TO
           USE EITHER THE 1975 OR 1980
           INTERNATIONAL GEOMAGNETIC REFERENCE
           FIELD (IGRF) MODEL.  BORB OUTPUTS 54
           PARAMETERS ON A LIST DIRECTED FILE
           INCLUDING THE SPHERICAL POLAR
           COMPONENTS OF THE FIELD, THE TOTAL
           MAGNITUDE OF THE FIELD AND THE
           MCLIWAIN PARAMETERS.  BORB IS A PART
           OF CAVA AND DOES NOT RUN STANDALONG.
           THE VEHICLE'S EMPHEMERIS AND
           ATTITUDE TIMELINE MUST BE LOADED IN
           VIA THE OTHER OPTIONS IN CAVA BEFORE
           RUNNING BORB.

-------------------------------------------------------------------------------------------------------------------------------------
```

SW NAME	SW FUNCTION	MODE OF USE	SKILL REQMTS TYPE	SKILL REQMTS LEVEL	LANGUAGE	LINES	MEMORY (BYTES)	RUNTIME (MIN)
CAVA/CAVMP /KEYGN	(COMBINED ATTITUDE AND VISIBILITY ANALYSIS) THIS PROGRAM COMBINES SEVERAL INTERRELATED FUNCTIONS FOR ATTITUDE AND VISIBILITY ANALYSIS. IT COMPUTES AN ATTITUDE TIMELINE USING KEYWORD TABLE DATA AND A MANEUVER TIMELINE (KEYGEN); GENERATES A SPACECRAFT OCCULTATION IMAGE ON A CELESTIAL SPHERE AS SEEN FROM A SPECIFIED ANTENNA OR SENSOR COORDINATE SYSTEM ABOARD A SPACECRAFT (ASOC); GENERATES ACQUISITION AND LOSS TIMES OF CELESTIAL OR EARTH-FIXED TARGETS BY SENSORS ABOARD A SPACECRAFT IN EARTH ORBIT (CAVIMP); COMPUTES GEOMAGNETIC FIELD PARAMETERS IN THE ORBITER COORDINATE SYSTEM (BORB); AND DISPLAYS CALCULATED ATTITUDE DATA VIA A TEKTRONIX 4014 TERMINAL OR ALTERNATE FILE (ATTDOC).	INTERACTIVE	ORBIT	PROFICIENT	FORTRAN	20072	1539000	25
CG	COMBINES ALL INPUT FILES TO PRODUCE A PRINTOUT OF ALL "ON ORBIT" ACTIVITIES AND ALL CORRESPONDING POCC ACTIVITIES.	INTERACTIVE	EXP CMD PLNG	PROFICIENT	FORTRAN	2600	45824	180
CHECK	VERIFIES THAT THE COMMANDS LISTED IN THE INPUT FILE ARE LEGAL COMMANDS TO THAT EXPERIMENT AND WITHOUT TYPOGRAPHICAL ERROR.	INTERACTIVE	EXP CMD PLNG	PROFICIENT	FORTRAN	2460	13824	45
CMDATG	PRODUCES THE COMMAND TIMELINE PRINTOUT FROM THE INPUT FILE.	INTERACTIVE	EXP CMD PLNG	PROFICIENT	FORTRAN	2046	26368	120

SW NAME	SW FUNCTION	MODE OF USE	SKILL REQMTS TYPE	SKILL REQMTS LEVEL	LANGUAGE	LINES	MEMORY (BYTES)	RUNTIME (MIN)
DEL.COM	CONVERT FILE FORMAT FROM ASCII TO EBCDIC	INTERACTIVE	MMU	PROFICIENT	DCL	338	14848	150
DFAST/DFRG	THIS DFAST MODULE CONSISTS OF A SET OF EXECUTABLES THAT CREATE TABULAR OR PLOT REPORT INFORMATION. THESE EXECUTABLES INCLUDE DATA MANAGEMENT CHECKLIST, MISSION ACTIVITY PLOTS, PLAYBACK REPORTS, ANTENNA DISPLAYS, ETC..	INTERACTIVE	DATA	EXPERT	FORTRAN	42383	921600	50
DFAST/DVM	THIS DFAST MODULE IS USED TO VERIFY DATA FLOW SCHEDULES.	INTERACTIVE	DATA	EXPERT	FORTRAN	10838	665600	3
DFAST/HFS	THIS DFAST MODULE SELECTS THE FORMATS THAT WILL BE IN OPERATION DURING A SPACELAB MISSION.	INTERACTIVE	DATA	PROFICIENT	FORTRAN	7908	358400	1
DFAST/HPFG	THIS DFAST MODULE IDENTIFIES ALL FORMATS POSSIBLE AT ANY GIVEN TIME DURING A MISSION.	INTERACTIVE	DATA	PROFICIENT	FORTRAN	2630	204800	1
DFAST/MDRP G	THIS DFAST MODULE DEVELOPS A FILE TO BE USED IN THE DATA FLOW ANALYSIS TO DEFINE EXPERIMENT AND SYSTEM REQUIREMENTS AND CAPABILITIES.	INTERACTIVE	DATA	EXPERT	FORTRAN	5031	563200	1
DFAST/MWG	THIS DFAST MODULE DEFINES TDRS COVERAGE, REALTIME DOWNLINK, HDRR DUMP WINDOWS.	INTERACTIVE	DATA	EXPERT	FORTRAN	16608	819200	1
DFAST/ORS	THIS DFAST MODULE SCHEDULES ONBOARD RECORDER AND REALTIME DOWNLINKS.	INTERACTIVE	DATA	EXPERT	FORTRAN	15587	819200	1

SW NAME	SW FUNCTION	MODE OF USE	SKILL REQMTS TYPE	SKILL REQMTS LEVEL	LANGUAGE	LINES	MEMORY (BYTES)	RUNTIME (MIN)
DFAST/PBS	THIS DFAST MODULE SCHEDULES PLAYBACKS FOR THE HDRR DUMPS.	INTERACTIVE	DATA	PROFICIENT	FORTRAN	16498	307200	1
DFAST/PCS	THIS DFAST MODULE DEFINES ROUTING OF REALTIME DATA IN THE POCC.	INTERACTIVE	DATA	PROFICIENT	FORTRAN	5555	307200	1
DFAST/PPCG	THIS DFAST MODULE ESTABLISHES A LIST OF POSSIBLE REALTIME POCC CONFIGURATION.	INTERACTIVE	DATA	PROFICIENT	FORTRAN	9396	358400	1
EDT	THE VAX EDITOR ALLOWS RANDOM ACCESS TO A LIST OF COMMANDS/ACTIVITIES IN COMPUTER MEMORY. EACH ITEM IS ADDED, DELETED OR REVISED, ONE AT A TIME BY THE OPERATOR.	INTERACTIVE	ALL	NOVICE	VAX OPS SYSTEM	0	0	0
ESAL	(EARTH SITE ACQUISITION AND LOSS PROGRAM) THIS PROGRAM ANALYTICALLY COMPUTES THE TIMES AN ORBITING VEHICLE'S GROUND TRACK WILL ENTER AND EXIT POLYGONAL GROUND SITES.	INTERACTIVE	ORBIT	PROFICIENT	FORTRAN	1850	1286000	30
ESDAT	(EARTH SITE DATA) THIS PROGRAM ALLOWS THE USER TO DEFINE POLYGONAL GROUND SITES FOR USE IN THE ESAL PROGRAM.	INTERACTIVE	ORBIT	PROFICIENT	FORTRAN	700	1220000	45

SW NAME	SW FUNCTION	MODE OF USE	SKILL REQMTS TYPE	SKILL REQMTS LEVEL	LANGUAGE	LINES	MEMORY (BYTES)	RUNTIME (MIN)
ESP	THE EXPERIMENT SCHEDULING PROGRAM (ESP) GENERATES, MODIFIES, VERIFIES, & DOCUMENTS EXPERIMENT T/L'S. THE USER MAY SELECT EITHER AUTOMATIC SCHEDULING OR MANUAL KEY IN OF ACTIVITIES. IN EITHER CASE THE PROGRAM VERIFIES THAT CONSTRAINTS ARE NOT VIOLATED. WHEN EDITING ACTIVITIES MANUALLY, THE USER MAY ELECT TO ACCEPT WARNINGS THAT CERTAIN CONSTRAINTS HAVE BEEN VIOLATED & PRODUCE A T/L WITH VIOLATIONS. THE PROGRAM ALSO HAS AN OPTION TO VERIFY THAT CHANGES TO THE MODELS, MISSION CONSTRAINTS, AND/OR TARGET/ATTITUDE FILES HAVE NOT INVALIDATED A PREVIOUS EXPERIMENT TIMELINE.	INTERACTIVE	TIMELINE	PROFICIENT	FORTRAN	90000	3800	60
GENMTL	ASSEMBLES ALL MASTER TIMELINE EVENTS INTO CHRONOLOGICAL ORDER.	INTERACTIVE	MMU	PROFICIENT	FORTRAN	2528	57856	120

SW NAME	SW FUNCTION	MODE OF USE	SKILL REQMTS TYPE	SKILL REQMTS LEVEL	LANGUAGE	LINES	MEMORY (BYTES)	RUNTIME (MIN)
GIMBAL	(GIMBAL ANGLE PROGRAM) THIS PROGRAM ALLOWS THE USER TO DETERMINE THE CELESTIAL ROLLS TO USE IN IPS STELLAR OBSERVATIONS WHILE MINIMIZING THOSE ROLLS BETWEEN OBSERVATIONS. THIS IS DONE VIA AN ITERATIVE PROCESS IN WHICH THE USER CAN SPECIFY THE IPS GIMBAL ROLL IN AN INPUT FILE. GIMBAL OUTPUTS A LIST-DIRECTED FILE LISTING MET, SCIENCE AND GUIDE STAR POSITIONS, AND GIMBAL AND CELESTIAL ANGLES FOR EACH OBSERVATION.	INTERACTIVE	ORBIT	EXPERT	FORTRAN	1100	1216000	60
GSOLP-1	THE GUIDE STAR OBJECTIVE LOAD PROGRAM (GSOLP) HAS BEEN DEVELOPED EXCLUSIVELY TO SELECT GUIDE STARS FOR USE BY THE INERTIAL POINTING SYSTEM (IPS) ON ASTRO MISSIONS. THE PROGRAM HAS 5 KODULES TO PROVIDE: 1) SELECTION OF GUIDE STARS, 2) TABULATION AND PLOTTING OF SELECTED DATA, 3) OPTIMIZATION OF IPS GIMBAL ANGLES FOR OBJECTIVE LOADS, 4) GENERATION OF OBJECTIVE LOADS IN ASCII FORMAT, AND 5) GENERATION OF OBJECTIVE LOADS TO MMU FORMAT FOR REAL TIME UPLINK.	INTERACTIVE	ORBIT	PROFICIENT	FORTRAN	17460	3000	960

SW NAME	SW FUNCTION	MODE OF USE	SKILL REQMTS TYPE	SKILL REQMTS LEVEL	LANGUAGE	LINES	MEMORY (BYTES)	RUNTIME (MIN)
GSOLP-2	THE GUIDE STAR OBJECTIVE LOAD PROGRAM (GFOLP) HAS BEEN DEVELOPED EXCLUSIVELY TO SELECT GUIDE STARS FOR USE BY THE INERTIAL POINTING SYSTEM (IPS) ON ASTRO MISSIONS. THE PROGRAM HAS 5 MODULES TO PROVIDE: 1) SELECTION OF GUIDE STARS, 2) TABULATION AND PLOTTING OF SELECTED DATA, 3) OPTIMIZATION OF IPS GIMBAL ANGLES FOR OBJECTIVE LOADS, 4) GENERATION OF OBJECTIVE LOADS IN ASCII FORMAT, AND 5) GENERATION OF OBJECTIVE LOADS TO MMU FORMAT FOR REAL TIME UPLINK.	INTERACTIVE	ORBIT	PROFICIENT	FORTRAN	17460	3000	60
IDUS	INTERACTIVE DATA UPDATE SYSTEM FOR MODIFYING DATA FLOW SCHEDULES	INTERACTIVE	DATA	EXPERT	FORTRAN	31790	1177600	1
IPOL	(IPS POINTING LISTS PROGRAM) THIS PROGRAM OUTPUTS TWO FILES WHICH ARE LISTS DESCRIBING THE POINTINGS DONE BY THE IPS ON ASTRO MISSIONS. ONE IS AN ASCII FILE WHICH LISTS ALL THE ID'S OF SCHEDULED TARGETS IN ID ORDER. THIS FILE IS FOR THE PI TO ADD SEQUENCE NUMBERS TO AND THEN IT FEEDS INTO JOTF. THE SECOND OUTPUT FILE IS A LIST-DIRECTED FILE GIVING DATA ON EACH POINTING IN TIME ORDER. THIS FILE IS READ BY PCAP AND JOTF.	INTERACTIVE	ORBIT	PROFICIENT	FORTRAN	2200	2265000	30

SW NAME	SW FUNCTION	MODE OF USE	SKILL REQMTS TYPE	SKILL REQMTS LEVEL	LANGUAGE	LINES	MEMORY (BYTES)	RUNTIME (MIN)
JOTF	(JOINT OPERATIONS TARGET FILE PROGRAM) JOTF GENERATES THE JOINT OPERATIONS TARGET FILE WHICH IS AN MMU FORMAT FILE THAT IS UPLINKED TO THE ON-BOARD COMPUTER. THE JOTF FILE CONTAINS DATA FOR EACH OBSERVATION AND THAT DATA IS DISPLAYED ON BOARD BY CREW MEMBERS WHEN CALLED UP BY TARGET ID. THE DATA INCLUDES TARGET ID, NAME, RA, DEC, OBJECTIVE LOAD ROLL, START AND STOP TIMES, SEQUENCE NUMBERS, ETC. INPUTS REQUIRED BY JOTF ARE AN IPOL FILE, A SEQUENCE FILE, AN ASTRON SCHEULE, AND A COO FILE.	INTERACTIVE	ORBIT	PROFICIENT	ORBIT	1300	1184000	45
LANTIN	GENERTE AN INSERTAION VECTOR FROM ANY OF 4 SETS OF INPUT DATA.	INTERACTIVE	ORBIT	PROFICIENT	FORTRAN	2548	1228000	10
LTO-1	(LIST DIRECTED TO ON/OFF FILE). THE LTO PROGRAM TAKES AS INPUT A USER SPECIFIED LIST-DIRECTED FILE AND ACCEPTANCE CONDITIONS TO APPLY TO THAT FILE. LTO READS THE INPUT FILE SCANNING FOR PERIODS OF TIME DURING WHICH THE SPECIFIED CONDITIONS ARE SATISFIED. THE OUTPUT IS AN ON/OFF SUBJECT FILE CONTAINING THE TIMES AT WHICH THE SPECIFIED CONDITIONS ARE SATISFIED. THIS OUTPUT SUBJECT MAY BE WRITTEN ON A NEW ON/OFF FILE OR ADDED TO A EXISTING ONE.	INTERACTIVE	ORBIT	PROFICIENT	FORTRAN	351	1139000	15

SW NAME	SW FUNCTION	MODE OF USE	SKILL REQMTS TYPE	SKILL REQMTS LEVEL	LANGUAGE	LINES	MEMORY (BYTES)	RUNTIME (MIN)
LTO-2	(LIST-DIRECTED TO ON/OFF FILE). THE LTO PROGRAM TAKES AS INPUT A USER SPECIFIED LIST-DIRECTED FILE AND ACCEPTANCE CONDITIONS TO APPLY TO THAT FILE. LTO READS THE INPUT FILE SCANNING FOR PERIODS OF TIME DURING WHICH THE SPECIFIED CONDITIONS ARE SATISFIED. THE OUTPUT IS AN ON/OFF SUBJECT CONTAINING THE TIMES AT WHICH THE SPECIFIED CONDITIONS ARE SATISFIED. THIS OUTPUT SUBJECT MAY BE WRITTEN ON A NEW ON/OFF FILE OR ADDED TO AN EXISTING ONE.	INTERACTIVE	ORBIT	PROFICIENT	FORTRAN	351	1139000	150
LTO-3	(LIST DIRECTED TO ON/OFF FILE). THE LTO PROGRAM TAKES AS INPUT A USER SPECIFIED LIST-DIRECTED FILE AND ACCEPTANCE CONDITIONS TO APPLY TO THAT FILE. LTO READS THE INPUT FILE SCANNING FOR PERIODS OF TIME DURING WHICH THE SPECIFIED CONDITIONS ARE SATISFIED. THE OUTPUT IS AN ON/OFF SUBJECT FILE CONTAINING THE TIMES AT WHICH THE SPECIFIED CONDITIONS ARE SATISFIED. THIS OUTPUT SUBJECT MAY BE WRITTEN ON A NEW ON/OFF FILE OR ADDED TO A EXISTING ONE.	INTERACTIVE	ORBIT	PROFICIENT	FORTRAN	351	1139000	30

SW NAME	SW FUNCTION	MODE OF USE	SKILL REQMTS TYPE	SKILL REQMTS LEVEL	LANGUAGE	LINES	MEMORY (BYTES)	RUNTIME (MIN)
LTO-4	(LIST DIRECTED TO ON/OFF FILE). THE LTO PROGRAM TAKES AS INPUT A USER SPECIFIED LIST-DIRECTED FILE AND ACCEPTANCE CONDITIONS TO APPLY TO THAT FILE. LTO READS THE INPUT FILE SCANNING FOR PERIODS OF TIME DURING WHICH THE SPECIFIED CONDITIONS ARE SATISFIED. THE OUTPUT IS AN ON/OFF SUBJECT FILE CONTAINING THE TIMES AT WHICH THE SPECIFIED CONDITIONS ARE SATISFIED. THIS OUTPUT SUBJECT MAY BE WRITTEN ON A NEW ON/OFF FILE OR ADDED TO A EXISTING ONE.	INTERACTIVE	ORBIT	PROFICIENT	FORTRAN	351	1139000	60
LWAP	TO COMPUTE AND/OR DISPLAY LAUNCH WINDOW OPEN/CLOSE DATA BASED UPON LAUNCH, LANDING, AOA, TAL, RTLS, SHADOW ENTRY/EXIT, AND BELTA ANGLE CONSTRAINT DATA.	INTERACTIVE	ORBIT	PROFICIENT	FORTRAN	3900	2995000	12
MET	APPENDS MET TIMETAGS TO ALL ITEMS IN THE INPUT FILES(S). GENERATES MULTIPLE ON/OFF TIMES FOR ACTIVITIES. CREATES SEPERATE SECTION FOR EACH .IMP FILE THEN MERGES THEM TOGETHER.	INTERACTIVE	EXP CMD PLNG	PROFICIENT	FORTRAN	2046	19712	30

SW NAME	SW FUNCTION	MODE OF USE	SKILL REQMTS TYPE	SKILL REQMTS LEVEL	LANGUAGE	LINES	MEMORY (BYTES)	RUNTIME (MIN)
MMUALL	(MMU ALLOCATION) CREATES A MODEL OF THE LOCATIONS OF THE MMU FILES ON THE MMU MAGNETIC TAPE, USING THE ADDRESSES AND FILENAMES SPECIFIED BY THE INPUT. THE MODEL IS THEN USED TO SUM THE MOVEMENT BETWEEN TAPE LOCATIONS FOR THE ENTIRE MISSION. THE OUTPUT IS A SINGLE NUMBER REPRESENTING THE TOTAL DISTANCE TRAVELED (AND TOTAL FILE ACCESS WAIT TIME).	INTERACTIVE	MMU	EXPERT	FORTRAN	689	1000	30
NSEP	(NUMERICAL SATELLITE EPHEMERIS PROGRAM). THIS PROGRAM GENERATES AN ORBITAL EMPHEMERIS BY NUMERICAL INTEGRATION OF THE COWELL EQUATIONS OF MOTION. IT CONSIDERS THE SPACECRAFT'S ATTITUDE IN DETERMINING A COEFFICIENT OF DRAG AND THEN INTEGRATES THE EFFECTS OF ATMOSPHERIC DRAG USING JACCHIA'S MODEL OF THE ATMOSPHERE. INPUT INTO NSEP CONSISTS OF LAUNCH DATE AND TIME, AN INSERTION VECTOR, A CAVA INPUT FILE FROM WHICH ATTITUDE DATA IS READ, SOLAR ACTIVITY TABLES, VEHICLE MASS AND VEHICLE REFERENCE AREA. A COEFFICIENT OF DRAG TABLE MAY BE USED INSTEAD OF THE ATTITUDE DATA. OUTPUT IS IN THE FORM OF NSEP EPHEMERIS FILE.	INTERACTIVE	ORBIT	PROFICIENT	FORTRAN 77	3991	1211000	30

SW NAME	SW FUNCTION	MODE OF USE	SKILL REQMTS TYPE	SKILL REQMTS LEVEL	LANGUAGE	LINES	MEMORY (BYTES)	RUNTIME (MIN)
PAAC	(PROGRAM FOR ASTRONOMY ATTITUDE CALCULATIONS) THIS PROGRAM READS IN AN ON/OFF FILE AS WRITTEN BY ASTAR AND OUTPUTS A MANEUVER TIMELINE BY GOING BETWEEN TARGETS WITH EIGEN AXIS MANEUVERS. PAAC OUTPUTS AN ON/OFF MANEUVER TIMELINE AND A KEYWORD FILE SUITABLE FOR READING BY CAVA.	INTERACTIVE	ORBIT	EXPERT	FORTRAN	740	1392000	30
PCAP	BUILD, DISPLAY & PRINT PAYLOAD CREW ACTIVITY PLAN (PCAP) CHARTS WHICH DESCRIBE THE HOUR-BY-HOUR ACTIVITIES OF THE PAYLOAD CREW FOR SPACE SHUTTLE MISSIONS. THE MAIN PRODUCT OF THE PROGRAM IS DETAILED 1 HOUR CHARTS, PRODUCED ON A HIGH RESOLUTION LASER PRINTER, WHICH BECOME PART OF THE FAYLOAD FLIGHT DATA FILE (PFDF). THE PROGRAM ALLOWS THE USER TO DEFINE THE LAYOUT OF THE PLAN, TO SELECT THE DATA SOURCES, AND TO EDIT THE CREW PROCEDURES & NOTES.	INTERACTIVE	TIMELINE	PROFICIENT	FORTRAN	27000	2300	120

SW NAME	SW FUNCTION	MODE OF USE	SKILL REQNTS TYPE	SKILL REQNTS LEVEL	LANGUAGE	LINES	MEMORY (BYTES)	RUNTIME (MIN)
PMDSG	(POCC MMU DATA SET) GENERATOR. THIS PROGRAM GENERATES THE POCC MMU (MASS MEMORY UNIT) DATA SETS. THIS IS USED BY THE COMMAND SHELL FILLER PROGRAM TO GENERATE USER DATA SETS FOR EVENTUAL UPLINKING. DATA FROM AN ASEP MODE FILE, AND ON/OFF FILES CONTAINING SUN RISE/SET, MOON RISE/SET AND TDRS COVERAGE ARE READ IN. THE USER MUST SPECIFY THE START TIME OF THE DATA SET. A VERIFICATION REPORT WILL ALSO BE GENERATED IF DESIRED.	INTERACTIVE	ORBIT	PROFICIENT	FORTRAN	1200	1228000	20
PROCAM	(PROPELLANT CONSUMED BY ATTITUDE MANEUVERS) PROCAM CALCULATES THE AMOUNT OF RCS PROPELLANT CONSUMED BY ATTITUDE MANEUVERS DURING A MISSION. IT ALSO, AND MORE IMPORTANTLY, CALCULATES ATTITUDE RELATED INFORMATION. PROCAM READS IN AN ASEP MODE FILE AND A CAVA ATTITUDE TIMELINE FILE AND OUTPUTS A LIST DIRECTED FILE AND A CAVA ATTITUDE TIMELINE FILE AND OUTPUTS A LIST DIRECTED FILE. THE OUTPUT FILE CONTAINS RCS USAGE DATA ALONG WITH ATTITUDE RELATED DATA SUCH AS THE ATTITUDE AND ATTITUDE RATES IN 3 REFERENCE FRAMES; AZIMUTH AND ELEVATION OF THE RADIUS, VELOCITY, ANGULAR MOMENTUM, LUNAR AND SOLAR VECTORS; AND THE INERTIAL TO BODY TRANSFORMATION MATRIX.	INTERACTIVE	ORBIT	PROFICIENT	FORTRAN	4200	1328000	30

SW NAME	SW FUNCTION	MODE OF USE	SKILL REQNTS TYPE	SKILL REQNTS LEVEL	LANGUAGE	LINES	MEMORY (BYTES)	RUNTIME (MIN)
PTS	PRODUCE PAYLOAD TIMELINE SUMMARY (PTS) CHARTS WHICH SUMMARIZE THE PAYLOAD OPERATIONS OF A SHUTTLE MISSION IN 6-HOUR INCREMENTS.	INTERACTIVE	TIMELINE	PROFICIENT	FORTRAN	6200	1400	120
RADI2	(RADIATION II PROGRAM) THE RADI2 PROGRAM READS IN AN ASEP LIST-DIRECTED FILE (GROUND TRACK OR DETAILED) AND CALCULATES THE FLUX OF CHARGED PARTICLES AT EACH POINT ON THE FILE (LATITUDE, LONGITUDE AND ALTITUDE) ABOVE A SPECIFIED ENERGY THRESHOLD. THE FLUX CALCULATED IS FOR PROTONS, ELECTRONS AT SOLAR MAXIMUM AND ELECTRONS AT SOLAR MINIMUM. IT IS DETERMINED BY USING SOLAR MIN AND MAX ELECTRON MODELS AND SMOOTHER KLUGU-LENGHART PROTONS CONTAINED IN THE PROGRAM.	INTERACTIVE	ORBIT	PROFICIENT	FORTRAN	8060	1252000	30

```
                                                            SKILL REQMTS                                  MEMORY     RUNTIME
SW NAME     SW FUNCTION                          MODE OF USE   TYPE       LEVEL      LANGUAGE      LINES    (BYTES)     (MIN)
---------   -----------------------------------  -----------  ---------  ---------  ---------  ---------  ---------  ---------
READPI      (READ PI FILE)  READPI IS DESIGNED   INTERACTIVE  ORBIT      PROFICIENT FORTAN          2900    3468000         30
            TO CREATE AN INPUT FILE FOR ASTAR BY
            READING A PI PARAMETER (COO) FILE
            PLUS THE APPROPRIATE TARGET
            ACQ/LOSS, SHADOW, SAA AND TIMEGOAL
            FILES, AND STRUCTURES THIS DATA IN A
            FORM THAT ASTAR CAN INTERPRET.  IT
            ALSO PROVIDES THE CAPABILITY TO EDIT
            INDIVIDUAL PARAMETERS IN THE COO
            FILES AND PEFORMS A NUMBER OF
            QUALITY CHECKS ON THE INPUT DATA
            FILES.  AN ANGULAR DISTANCE MATRIX
            FOR ALL COMBINATIONS OF TARGETS IS
            THEN COMPUTED, AND, IF THE OPTION IS
            SELECTED, A SUN AVOIDANCE ROUTINE
            DETERMINES A "FORBIDDEN PAIR" LIST
            TO CURRENT ASTAR FROM SCHEDULING A
            MANEUVER PATH TOO CLOSE TO THE SUN.

-------------------------------------------------------------------------------------------------------------------------------
```

SW NAME	SW FUNCTION	MODE OF USE	SKILL REQMTS TYPE	SKILL REQMTS LEVEL	LANGUAGE	LINES	MEMORY (BYTES)	RUNTIME (MIN)
RELMO	RELMO IS DESIGNED TO GENERATE A TIMELINE HISTORY OF POSITIONS AND VELOCITIES FOR A SUBSATELLITE RELATIVE TO A SPACECRAFT BY SETTING UP A COORDINATE SYSTEM CENTERED IN ONE OF THE BODIES, AND USING THE DIFFERENTIAL EQUATIONS OF MOTIONS FOR THE OTHER BODY TO OBTAIN AN APPROXIMATE SOLUTION. THE PROGRAM OFFERS THE USER FOUR TARGETING OPTIONS AND PERFORMS THE CALCULATIONS FOR THE SELECTED OPTION. THE CAPABILITY EXISTS FOR DISPLAYING THIS TRAJECTORY DATA ON THE SCREEN, PRINTING THE DATA AND/OR STORING THE DATA ON A FILE.	INTERACTIVE	ORBIT	PROFICIENT	FORTRAN	2700	1241000	60

SW NAME	SW FUNCTION	MODE OF USE	SKILL REQMTS TYPE	SKILL REQMTS LEVEL	LANGUAGE	LINES	MEMORY (BYTES)	RUNTIME (MIN)
SALES	(SATELLITE ACQUISITION AND LOSS OVER EARTH SITE) THIS PROGRAM COMPUTES THE TIMES THAT AN EARTH SATELLITE ACQUIRES AND LOSES AN EARTH SITE. ACQUISITION/LOSS IS DEFINED BY AN ELEVATION ANGLE CONSTRAINT. FOR PURPOSES OF DETERMINING THE TIMES THAT A SATELLITE IS IN COMMUNICATION WITH A TRACKING STATION, TERRAIN EFFECTS CAN BE SIMULATED. TABULAR DATA AND PLOTS PROVIDE SUMMARY INFORAMTION SUCH AS THE EARTH-FIXED AZIMUTH AND ELEVATION OF THE VEHICLE, THE TIME AND DURATION OF THE PASS, MAXIMUM ELEVATION ANGLE REACHED. SALES READS AN ASEP EPHEMERIS FILE TO GET THE ORBITAL DATA NEEDED.	INTERACTIVE	ORBIT	PROFICIENT	FORTRAN	2886	1512000	45
SCATGEN	THE STAR CATALOG GENERATOR (SCATGEN) PROGRAM IS USED TO SELECT IPS GUIDE STARS AND GENERATE IPS OBJECTIVE LOADS FOR SOLAR OBSERVATIONS. A CATALOG OF CANDIDATE GUIDE STARS ARE SELECTED BY APPLYING CONSTRAINTS TO VARIOUS VARIABLES, AND MAKING COMPUTATIONS FROM VARIOUS VARIABLES ON THE MSFC SKYMAP CATALOG. ANY COMPUTATION CAN BE FITERED BY APPLYING A CONSTRAINT TO ITS OUTPUT.	INTERACTIVE	ORBIT	PROFICIENT	FORTRAN 77	4000	3733000	30

SW NAME	SW FUNCTION	MODE OF USE	SKILL REQMTS TYPE	SKILL REQMTS LEVEL	LANGUAGE	LINES	MEMORY (BYTES)	RUNTIME (MIN)
STAR-1	(STELLAR TARGET ACQUISITION AND LOSS ROUTINE) THIS PROGRAM ANALYTICALLY COMPUTES THE ACQUISITION AND LOSS TIMES OF CELESTIAL OBJECTS FROM ORBIT. ALSO CALCULATED ARE THE LOCATION IN THE ORBIT PLANE OF THE ACQUISITION AND LOSS, OBSERVATION TIME PER ORBIT, OBSERVATION TIME IN DARKNESS AND THE ANGLE BETWEEN THE TARGET AND THE SUN OR MOON. INPUT NEEDED ARE AN ASEP NODE FILE, A NAME-DIRECTED FILE CONTAINING A LIST OF TARGETS, AND A USER SPECIFIED ORBITAL ELEVATION ANGLE. OUTPUT IS IN THE FORM OF TABULATION AND/OR AN ON/OFF FILE.	INTERACTIVE	ORBIT	PROFICIENT	FORTRAN 77	2054	1308000	15
STAR-2	(STELLAR TARGET ACQUISITION AND LOSS ROUTINE) THIS PROGRAM ANALYTICALLY COMPUTES THE ACQUISITION AND LOSS TIMES OF CELESTIAL OBJECTS FROM ORBIT. ALSO CALCULATED ARE THE LOCATION IN THE ORBIT PLANE OF THE ACQUISITION AND LOSS, OBSERVATION TIME PER ORBIT, OBSERVATION TIME IN DARKNESS AND THE ANGLE BETWEEN THE TARGET AND THE SUN OR MOON. INPUT NEEDED ARE AN ASEP NODE FILE, A NAME-DIRECTED FILE CONTAINING A LIST OF TARGETS, AND A USER SPECIFIED ORBITAL ELEVATION ANGLE. OUTPUT IS IN THE FORM OF TABULATION AND/OR AN ON/OFF FILE.	INTERACTIVE	ORBIT	PROFICIENT	FORTRAN 77	2054	1308000	60

SW NAME	SW FUNCTION	MODE OF USE	SKILL REQNTS TYPE	SKILL REQNTS LEVEL	LANGUAGE	LINES	MEMORY (BYTES)	RUNTIME (MIN)
STLBUF	GENERATE SUBORDINATE TIMELINE BUFFER UTILIZATION REPORT	AUTOMATIC	MMU	PROFICIENT	FORTRAN	3648	48640	600
SUBCOO	SUBCOO IS A PROGRAM USED TO CREATE NEW FILES THAT ARE A SUBSET OF THE PI COOBSERVATION FILE. IT GENERATES SUBSETS ACCORDING TO USER CONTROLLED CONSTRAINTS BY INTERSECTIONS, UNIONS AND INDIVIDUAL PARAMETERS. IT CAN WRITE AN ASCII FILE LIKE THE COOBSERVATION FILE OR A NAME-DIRECTED FILE FOR OTHER SOFTWARE.	INTERACTIVE	ORBIT	PROFICIENT	FORTRAN	1500	1261000	30
TAE	THE TARGET/ATTITUDE EDITOR (TAE) PROGRAM PERFORMS DATA BASE OPERATIONS ON ESS TARGET/ATTITUDE FILES. THE OPERATIONS AVAILABLE INCLUDE EDITING, DELETING AND ADDING ACQUISITION PERIODS; DELETING SUBJECTS; CREATING UNIONS, INTERSECTIONS & COMPLEMENTS OF SUBJECTS; COPYING SUBJECTS FROM OTHER FILES AND DISPLAYING & PRINTING DATA. THE PROGRAM CAN READ O/O FILES & CONVERT THEM TO THE ESS TARGET/ATTITUDE FORMAT. WHEN RE-FORMATTING, ACQUISITION PERIODS CAN BE MAINTAINED EXACTLY OR EXPANDED TO THE NEXT WHOLE MINUTE ON EACH END.	INTERACTIVE	TIMELINE	PROFICIENT	FORTRAN	10000	3100	30

SW NAME	SW FUNCTION	MODE OF USE	SKILL REQNTS TYPE	 LEVEL	LANGUAGE	LINES	MEMORY (BYTES)	RUNTIME (MIN)
TANRAY	(TANGENT RAY PROGRAM) TANRAY COMPUTES A DETAILED TIME HISTORY OF SUN RISES AND SUN SETS AS SEEN ALONG A LINE OF SIGHT (RAY) FROM THE ORBITER TO THE SUN. THAT LINE WILL HAVE A POINT ON IT WHICH IS CLOSEST TO THE SURFACE OF THE EARTH, REFERED TO AS THE TANGENT POINT. THE USER INPUTS A VECTOR FOR THE ORBIT WHICH TANRAY PROPOGATES INTERNALLY, A PAIR OF START AND STOP TIMES, A DELTA TIME FOR THE CALCULATIONS, AND A MINIMUM AND MAXIMUM TANGENT RAY HEIGHT. OUTPUTS FROM TANRAY ARE A LIST-DIRECTED FILE OF 63 VARIABLES, A TABULATION OF A SUB-SET OF THOSE VARIABLES TO THE SCREEN, AND/OR ON/OFF FILE OF SUN RISE/SET TIME HISTORY.	INTERACTIVE	ORBIT	PROFICIENT	FORTRAN	1625	1387000	60

SW NAME	SW FUNCTION	MODE OF USE	SKILL REQNTS TYPE	SKILL REQNTS LEVEL	LANGUAGE	LINES	MEMORY (BYTES)	RUNTIME (MIN)
TARGEN	(TARGET GENERATOR PROGRAM). THIS PROGRAM IS USED TO GENERATE EXPERIMENT OPERATION OPPORTUNITIES FROM VARIOUS FILES AND FILE TYPES WHICH ARE USED IN ORBITAL ANALYSIS AND MISSION PLANNING. THESE TARGETS OF OPPORTUNITY ARE GENERATED IN TARGEN FROM TARGET DEFINITIONS THE USER CREATES AND MAY STORE. THESE TARGET DEFINITIONS SPECIFY CONSTRAINTS TO BE APPLIED TO FILES AND HOW THESE FILES ARE THEN COMBINED USING ELEMENTRY SET THEORY. THE INPUT FILES MAY BE LIST-DIRECTED OR ON/OF, AND THE OUTPUT FILES ARE ON/OFF TYPE. TARGEN ALSO HAS OPTIONS TO TABULATE OR DRAW BAR CHARTS OF DATA ON AN ON/OFF FILE.	INTERACTIVE	ORBIT	PROFICIENT	FORTAN	10556	1613000	15
VECTOR	THIS PROGRAM TAKES AS INPUT A LAUNCH DATE AND TIME AND A STATE VECTOR EXACTLY AS ACQUIRED FROM JSC (IN ENGLISH UNITS). IT THEN CONVERTS THAT VECTOR TO METRIC UNITS AND DISPLAYS THE EQUIVALENT IN MEAN CLASSICAL ELEMENTS FOR THE USER TO CHECK ITS VALIDITY. THE PROGRAM THEN HAS THE ABILITY TO STORE THE VECTOR IN ITS APPROPRIATE FORM AND UNITS IN THE CASE STORAGE FILES OF ASEP, NSEP AND/OR TANRAY. THIS ALLOWS THE USER TO KEY IN THE VECTOR ONLY ONCE FOR ALL THREE PROGRAMS.	INTERACTIVE	ORBIT	PROFICIENT	FORTRAN 77	1469	1378000	10

SW NAME	SW FUNCTION	MODE OF USE	SKILL REQMTS TYPE	SKILL REQMTS LEVEL	LANGUAGE	LINES	MEMORY (BYTES)	RUNTIME (MIN)
VERMI	TO VERIFY THAT THE INPUT .MI FILE IS LEGAL AND FREE OF ALL TYPOGRAPHIC ERROS.	INTERACTIVE	MMU	PROFICIENT	FORTRAN	826	49664	5
VERMTL	VERIFY SYNTAX OF ALL MASTER TIMELINES	INTERACTIVE	MMU	PROFICIENT	FORTRAN	1500	91136	60
VERSTL	TO VERIFY THE SYNTAX OF SUBORDINATE TIMELINES.	INTERACTIVE	MMU	PROFICIENT	FORTRAN	1631	60416	1
VME	THE VT100 MODEL EDITOR PROGRAM(VME) IS A DATA BASE MANAGEMENT TOOL USED TO CREATE, MODIFY AND COPY ESS EXPERIMENT MODEL FILES. VME MAKES EXTENSIVE USE OF FORM EDITING TECHNIQUES TO EDIT THE DATA. IT USES THE SPECIAL FEATURES OF THE VT100 SUCH AS DIRECT CURSOR POSITIONING, SCROLLING AND VIDEO RENDITIONS TO PRESENT DATA AND SOLICIT INPUTS.	INTERACTIVE	TIMELINE	PROFICIENT	FORTRAN	40000	1900	60

TABLE 5
SOFTWARE PERIPHERALS REQUIRED

```
SOFTWARE PERIPHERALS REQUIRED    DATE 03/17/87

                                 PAGE          1

  SOFTWARE NAME          PERIPHERAL REQUIRED
  ---------------        -------------------
  ASEP                    TEKTRONIX 4014
  ASTAR                   ANY TERMINAL
  ASTRO                   ANY TERMINAL
  ATMOS                   ANY TERMINAL
  BORB                    TEKTRONIX 4014
  CAVA/CAVINP             TEKTRONIX 4014
  CAVA/KEYGEN             TEKTRONIX 4014
  CG                      VAX TERMINAL
  CHECK                   VAX TERMINAL
  CMDATG                  VAX TERMINAL
  DEL.CON                 VAX TERMINAL
  DF/DFRG                 TEKTRONIX 4014
  DF/DVM                  VAX TERMINAL
  DF/HFS                  VAX TERMINAL
  DF/HPFG                 VAX TERMINAL
  DF/MDRPG                VAX TERMINAL
  DF/MWG                  VAX TERMINAL
  DF/ORS                  VAX TERMINAL
  DF/PBS                  VAX TERMINAL
  DF/PCS                  VAX TERMINAL
  DF/PPCG                 VAX TERMINAL
  EDT                     VAX TERMINAL
  ESAL                    TEKTRONIX 4014
  ESDAT                   TEKTRONIX 4014
  ESP                     VT241,100,TEKTR.
  GENMTL                  VAX TERMINAL
  GIMBAL                  ANY TERMINAL
  GSOLP                   ANY TERMINAL
  IDUS                    VAX TERMINAL
  IPOL                    ANY TERMINAL
  JOTF                    ANY TERMINAL
  LANTIM                  ANY TERMINAL
  LTO                     ANY TERMINAL
  LWAP                    ANY TERMINAL
  MET                     VAX TERMINAL
  MMUALL                  VAX TERMINAL
  ..........................................
```

```
SOFTWARE NAME          PERIPHERAL REQUIRED
---------------        -------------------
NSEP                    ANY TERMINAL
PAAC                    ANY TERMINAL
PCAP                    VT241
PMDSG                   ANY TERMINAL
PROCAM                  ANY TERMINAL
PTS                     VT100,TEKTR.
RADI2                   ANY TERMINAL
READPI                  ANY TERMINAL
RELMO                   TEKTRONIX 4014
SALES                   TEKTRONIX 4014
SCATGEN                 ANY TERMINAL
STAR                    ANY TERMINAL
STLBUF                  VAX TERMINAL
SUBCOO                  ANY TERMINAL
TAE                     VT241,100,TEKTR.
TANRAY                  TEKTRONIX 4014
TARGEN                  ANY TERMINAL
VECTOR                  ANY TERMINAL
VERMI                   VAX TERMINAL
VERMTL                  VAX TERMINAL
VERSTL                  VAX TERMINAL
VME                     VT241,100,TEKTR.
--------------------------------------------
```

TABLE 6
ACTIVITY INPUT/OUTPUTS

ACTIVITY INPUT/OUTPUTS

ACTIVITY	INPUT/OUTPUT NAME	I/O FORM	SW ASSOC. WITH	TYPE	SOURCE/DESTINATION	CYCLES INPUT/OUTPUT DURING PREL	BASIC	UPDT	RPLNG
PAYLOAD DATA COLLECTION	PI INTERFACE	MANUAL	NONE	I	PI DISCUSSIONS	Y	Y	Y	N
PAYLOAD DATA COLLECTION	ERD'S	MANUAL	NONE	I	PI DEVELOPED (EXPERIMENT REQUIREMENTS)	Y	Y	N	N
PAYLOAD DATA COLLECTION	PAYLOAD COMPLEMENT DEFINITION	MANUAL	NONE	I	HDQRS	Y	Y	N	N
PAYLOAD DATA COLLECTION	INPUTS/UPDATES TO O&IA	MANUAL	NONE	O	CREATE DATA FLOW MODEL(S)	Y	Y	Y	N
PAYLOAD DATA COLLECTION	INPUTS/UPDATES TO IPRD	MANUAL	NONE	O	PI'S (FOR ASSESSMENT OF ALLOCATIONS)	Y	Y	N	N
PAYLOAD DATA COLLECTION	INPUTS/UPDATES TO O&IA	MANUAL	NONE	O	ORBIT REQUIREMENTS EVALUATION AND SELECTION	Y	Y	Y	N
PAYLOAD DATA COLLECTION	INPUTS/UPDATES TO O&IA	MANUAL	NONE	O	CREATE MISSION TIMELINE MODEL(S)	Y	Y	Y	N
ORBIT REQUIREMENTS EVALUATION AND SELECTION	PI INTERFACE	MANUAL	NONE	I	PI DISCUSSIONS	Y	Y	Y	N
ORBIT REQUIREMENTS EVALUATION AND SELECTION	ERD'S	MANUAL	NONE	I	PI DEVELOPED (EXPERIMENT REQUIREMENTS)	Y	N	N	N
ORBIT REQUIREMENTS EVALUATION AND SELECTION	STS CAPABILITIES DOCUMENTATION	MANUAL	NONE	I	STS CTR DEVELOPED	N	Y	Y	N

ACTIVITY	INPUT/OUTPUT NAME	I/O FORM	SW ASSOC. WITH	TYPE	SOURCE/DESTINATION	CYCLES INPUT/OUTPUT DURING PREL	BASIC	UPDT	RPLNG
ORBIT REQUIREMENTS EVALUATION AND SELECTION	O&IA	MANUAL	NONE	I	PL CTR DEVELOPED	N	Y	Y	N
ORBIT REQUIREMENTS EVALUATION AND SELECTION	ORBIT DEFINITION PARAMETERS	MANUAL	NONE	O	LAUNCH WINDOW/LAUNCH TIME SELECTION	Y	Y	Y	N
ORBIT REQUIREMENTS EVALUATION AND SELECTION	ORBIT DEFINITION PARAMETERS	MANUAL	NONE	O	GENERATE STATE VECTOR	Y	Y	Y	N
LAUNCH WINDOW/LAUNCH TIME SELECTION	PL/EXP CONSTRAINTS	MANUAL	LWAP	I	DOCUMENTATION (ERD'S,O&IA'S), PI INTERFACE	Y	Y	Y	N
LAUNCH WINDOW/LAUNCH TIME SELECTION	STS CONSTRAINTS	MANUAL	LWAP	I	STS CAPABILITIES DOCUMENTATION	Y	Y	Y	N
LAUNCH WINDOW/LAUNCH TIME SELECTION	ORBIT DEFINITION PARAMETERS	MANUAL	LWAP	I	ORBIT REQUIREMENTS EVALUATION AND SELECTION	Y	Y	Y	N
LAUNCH WINDOW/LAUNCH TIME SELECTION	LAUNCH WINDOW/LAUNCH TIME DATA	COMPUTER	LWAP	O	GENERATE STATE VECTOR	Y	Y	Y	N
LAUNCH WINDOW/LAUNCH TIME SELECTION	LAUNCH WINDOW/LAUNCH TIME DATA	COMPUTER	LWAP	O	GENERATE CANDIDATE SOLAR GUIDE STARS	Y	Y	Y	N
GENERATE STATE VECTOR	ORBIT DEFINITION PARAMETERS	MANUAL	LANTIN	I	ORBIT REQUIREMENTS EVALUATION AND SELECTION	Y	N	N	N

ACTIVITY INPUT/OUTPUTS

ACTIVITY	INPUT/OUTPUT NAME	I/O FORM	SW ASSOC. WITH	TYPE	SOURCE/DESTINATION	CYCLES INPUT/OUTPUT DURING PREL	BASIC	UPDT	RPLNG
GENERATE STATE VECTOR	LAUNCH WINDOW/LAUNCH TIME DATA	MANUAL	LANTIM	I	LAUNCH WINDOW/LAUNCH TIME SELECTION	Y	N	N	N
GENERATE STATE VECTOR	STATE VECTOR PRINTOUT	COMPUTER	LANTIM	O	COMPUTE ORIENTATION AND STRENGHT OF MAGNETIC FIELD IN THE ORBITER COORDINATE SYSTEM	Y	N	N	N
GENERATE STATE VECTOR	STATE VECTOR PRINTOUT	COMPUTER	LANTIM	O	GENERATE ORBITAL EPHEMERIS BY NUMERICAL INTEGRATION	Y	N	N	N
GENERATE STATE VECTOR	STATE VECTOR PRINTOUT	COMPUTER	LANTIM	O	COMPUTE DISTANCE FROM TANGENT POINT ON THE ORBITER TO SUN LINE-OF-SIGHT TO EARTH SURFACE	Y	N	N	N
GENERATE STATE VECTOR	STATE VECTOR PRINTOUT	COMPUTER	LANTIM	O	GENERATE REQUIRED EPHEMERIS DATA FOR OUTPUT	Y	N	N	N
CONVERT/STORE STATE VECTOR	STATE VECTOR ELECTRONIC	COMPUTER	VECTOR	I	JSC	N	N	N	Y
CONVERT/STORE STATE VECTOR	STATE VECTOR FROM JSC	MANUAL	VECTOR	I	JSC	Y	Y	Y	Y
CONVERT/STORE STATE VECTOR	CASE STO	COMPUTER	VECTOR	O	GENERATE REQUIRED EPHEMERIS DATA FOR OUTPUT	Y	Y	Y	Y

```
                                         ACTIVITY INPUT/OUTPUTS                              DATE 03/19/87

                                                                                             PAGE          4

                                                              SW ASSOC.                                CYCLES INPUT/OUTPUT DURING
ACTIVITY              INPUT/OUTPUT NAME    I/O FORM    WITH      TYPE         SOURCE/DESTINATION     PREL   BASIC  UPDT  RPLNG
--------------------  -------------------  ----------  ----------  ----------  --------------------   ----   -----  ----  -----
CONVERT/STORE STATE   CASE STO             COMPUTER    VECTOR      O           GENERATE ORBITAL        Y      Y     Y      Y
VECTOR                                                                         EPHEMERIS BY
                                                                               NUMERICAL INTEGRATION

CONVERT/STORE STATE   CASE STO             COMPUTER    VECTOR      O           GENERATE EARTH SHADOW   Y      Y     Y      Y
VECTOR                                                                         ACQ/LOSS

GENERATE ORBITAL      CASE STO             COMPUTER    NSEP        I           CONVERT/STORE STATE     Y      Y     Y      Y
EPHEMERIS BY                                                                   VECTOR
NUMERICAL
INTEGRATION

GENERATE ORBITAL      STATE VECTOR         MANUAL      NSEP        I           GENERATE STATE VECTOR   Y      Y     Y      Y
EPHEMERIS BY          PRINTOUT
NUMERICAL
INTEGRATION

GENERATE ORBITAL      NSEP EPHEM           COMPUTER    NSEP        O           GENERATE REQUIRED       Y      Y     Y      Y
EPHEMERIS BY                                                                   EPHEMERIS DATA FOR
NUMERICAL                                                                      OUTPUT
INTEGRATION

GENERATE REQUIRED     NSEP EPHEM           COMPUTER    ASEP        I           GENERATE ORBITAL        Y      Y     Y      Y
EPHEMERIS DATA FOR                                                             EPHEMERIS BY
OUTPUT                                                                         NUMERICAL INTEGRATION

GENERATE REQUIRED     CASE STO             COMPUTER    ASEP        I           CONVERT/STORE STATE     Y      Y     Y      Y
EPHEMERIS DATA FOR                                                             VECTOR
OUTPUT

GENERATE REQUIRED     STATE VECTOR         MANUAL      ASEP        I           GENERATE STATE VECTOR   Y      Y     Y      Y
EPHEMERIS DATA FOR    PRINTOUT
OUTPUT

-----------------------------------------------------------------------------------------------------------------------------
```

ACTIVITY	INPUT/OUTPUT NAME	I/O FORM	SW ASSOC. WITH	TYPE	SOURCE/DESTINATION	CYCLES INPUT/OUTPUT DURING PREL	BASIC	UPDT	RPLNG
GENERATE REQUIRED EPHEMERIS DATA FOR OUTPUT	GND TRK	COMPUTER	ASEP	O	DEVELOP/APPLY CONSTRAINTS TO EARTH OBSERVATION TARGETS	Y	Y	Y	Y
GENERATE REQUIRED EPHEMERIS DATA FOR OUTPUT	DETAIL EPHEM	COMPUTER	ASEP	O	GENERATE RADIATION ENVIRONMENT	Y	Y	Y	Y
GENERATE REQUIRED EPHEMERIS DATA FOR OUTPUT	ASCN NODE	COMPUTER	ASEP	O	COMPUTE ORIENTATION AND STRENGTH OF MAGNETIC FIELD IN THE ORBITER COORDINATE SYSTEM	Y	Y	Y	Y
GENERATE REQUIRED EPHEMERIS DATA FOR OUTPUT	GND TRK	COMPUTER	ASEP	O	GENERATE PTS CHARTS	Y	Y	Y	Y
GENERATE REQUIRED EPHEMERIS DATA FOR OUTPUT	ASCN NODE	COMPUTER	ASEP	O	GENERATE POCC MMU DATA SET	Y	Y	Y	Y
GENERATE REQUIRED EPHEMERIS DATA FOR OUTPUT	DETAIL EPHEM	COMPUTER	ASEP	O	GENERATE GROUND STATION COVERAGE	Y	Y	Y	Y
GENERATE REQUIRED EPHEMERIS DATA FOR OUTPUT	ASCN NODE	COMPUTER	ASEP	O	GENERATE PRELIMINARY TDRS COVERAGE	Y	Y	Y	N
GENERATE REQUIRED EPHEMERIS DATA FOR OUTPUT	ASCN NODE	COMPUTER	ASEP	O	GENERATE TDRS COVERAGE	Y	Y	Y	Y

ACTIVITY	INPUT/OUTPUT NAME	I/O FORM	SW ASSOC. WITH	TYPE	SOURCE/DESTINATION	CYCLES INPUT/OUTPUT DURING			
						PREL	BASIC	UPDT	RPLNG
GENERATE REQUIRED EPHEMERIS DATA FOR OUTPUT	DETAIL EPHEM	COMPUTER	ASEP	O	GENERATE ORBITER POINTING DATA	Y	Y	Y	Y
GENERATE REQUIRED EPHEMERIS DATA FOR OUTPUT	GND TRK	COMPUTER	ASEP	O	DEVELOP CONSTRAINTS FOR SOLAR VIEWING PERIODS	Y	Y	Y	Y
GENERATE REQUIRED EPHEMERIS DATA FOR OUTPUT	GND TRK	COMPUTER	ASEP	O	GENERATE HEMISPHERE OPPORTUNITIES	Y	Y	Y	Y
GENERATE REQUIRED EPHEMERIS DATA FOR OUTPUT	DETAIL EPHEM	COMPUTER	ASEP	O	DEVELOP/APPLY CONSTRAINTS TO EARTH OBSERVATION TARGETS	Y	Y	Y	Y
GENERATE REQUIRED EPHEMERIS DATA FOR OUTPUT	ASCN NODE	COMPUTER	ASEP	O	COMPUTE SUN AZIMUTH AND ELEVATION FROM ORBITING VEHICLE WITH RESPECT TO SUN RISE/SET EVENTS	N	N	N	Y
GENERATE REQUIRED EPHEMERIS DATA FOR OUTPUT	ASCN NODE	COMPUTER	ASEP	O	GENERATE MOON RISE/SET	Y	Y	Y	Y
GENERATE REQUIRED EPHEMERIS DATA FOR OUTPUT	ASCN NODE	COMPUTER	ASEP	O	GENERATE CELESTIAL TARGET(S) ACQ/LOSS	Y	Y	Y	Y
GENERATE REQUIRED EPHEMERIS DATA FOR OUTPUT	ASCN NODE	COMPUTER	ASEP	O	GENERATE ACQ/LOSS OF GROUND SITE TARGET AREAS	Y	Y	Y	Y

ACTIVITY	INPUT/OUTPUT NAME	I/O FORM	SW ASSOC. WITH	TYPE	SOURCE/DESTINATION	CYCLES INPUT/OUTPUT DURING PREL	BASIC	UPDT	RPLNG
GENERATE EARTH SHADOW ACQ/LOSS	CASE STO	COMPUTER	ASEP	I	CONVERT/STORE STATE VECTOR	Y	Y	Y	Y
GENERATE EARTH SHADOW ACQ/LOSS	EARTH SHADOW	COMPUTER	ASEP	O	GENERATE SUN RISE/SET	Y	Y	Y	Y
GENERATE EARTH SHADOW ACQ/LOSS	EARTH SHADOW	COMPUTER	ASEP	O	CREATE COMMON FILE FOR ASTAR PROGRAM (DS)	Y	Y	Y	Y
GENERATE EARTH SHADOW ACQ/LOSS	EARTH SHADOW	COMPUTER	ASEP	O	SCHEDULE SCIENCE OBSERVATIONS (DS)	Y	Y	Y	Y
GENERATE EARTH SHADOW ACQ/LOSS	EARTH SHADOW	COMPUTER	ASEP	O	COMPUTE SUN AZIMUTH AND ELEVATION FROM ORBITING VEHICLE WITH RESPECT TO SUN RISE/SET EVENTS	N	N	N	Y
GENERATE EARTH SHADOW ACQ/LOSS	EARTH SHADOW	COMPUTER	ASEP	O	COMBINE CONSTRAINTS TO DETERMINE CELESTIAL TARGETS AND MERGE FILES	Y	Y	Y	Y
GENERATE SUN RISE/SET	EARTH SHADOW	COMPUTER	TARGEN	I	GENERATE EARTH SHADOW ACQ/LOSS	Y	Y	Y	Y
GENERATE SUN RISE/SET	SUN RISE/SET	COMPUTER	TARGEN	O	COMBINE CONSTRAINTS TO DETERMINE SOLAR TARGETS	Y	Y	Y	Y
GENERATE SUN RISE/SET	SUN RISE/SET	COMPUTER	TARGEN	O	MERGE MISSION INDEPENDENT TARGETS	Y	Y	Y	Y

ACTIVITY INPUT/OUTPUTS

ACTIVITY	INPUT/OUTPUT NAME	I/O FORM	SW ASSOC. WITH	TYPE	SOURCE/DESTINATION	CYCLES INPUT/OUTPUT DURING			
						PREL	BASIC	UPDT	RPLNG
GENERATE SUN RISE/SET	SUN RISE/SET	COMPUTER	TARGEN	O	COMPUTE ORBIT TERMINATOR TARGETS	Y	Y	Y	Y
GENERATE MOON RISE/SET	ASCN NODE	COMPUTER	STAR	I	GENERATE REQUIRED EPHEMERIS DATA FOR OUTPUT	Y	Y	Y	Y
GENERATE MOON RISE/SET	MOON RISE/SET	COMPUTER	STAR	O	MERGE MISSION INDEPENDENT TARGETS	Y	Y	Y	Y
GENERATE PRELIMINARY TDRS COVERAGE	PREL ATT TL	COMPUTER	CAVINP	I	DEVELOP PRELIMINARY ATTITUDE TIMELINE	Y	Y	Y	N
GENERATE PRELIMINARY TDRS COVERAGE	ASCN NODE	COMPUTER	CAVINP	I	GENERATE REQUIRED EPHEMERIS DATA FOR OUTPUT	Y	Y	Y	N
GENERATE PRELIMINARY TDRS COVERAGE	ORBITER OCCULT	COMPUTER	CAVINP	I	JSC	Y	N	N	N
GENERATE PRELIMINARY TDRS COVERAGE	PREL TDRS AC/LOS	COMPUTER	CAVINP	O	COMBINE CONSTRAINTS TO DETERMINE SOLAR TARGETS	Y	Y	Y	N
GENERATE PRELIMINARY TDRS COVERAGE	PREL TDRS AC/LOS	COMPUTER	CAVINP	O	MERGE MISSION INDEPENDENT TARGETS	Y	Y	Y	N
GENERATE PRELIMINARY TDRS COVERAGE	PREL TDRS AC/LOS	COMPUTER	CAVINP	O	EDIT CURRENT ATTITUDE T/L TO INCORPORATE STS OR OTHER REQMTS	Y	Y	Y	N
GENERATE GROUND STATION COVERAGE	DETAIL EPHEM	COMPUTER	SALES	I	GENERATE REQUIRED EPHEMERIS DATA FOR OUTPUT	Y	Y	Y	Y

ACTIVITY	INPUT/OUTPUT NAME	I/O FORM	SW ASSOC. WITH	TYPE	SOURCE/DESTINATION	CYCLES INPUT/OUTPUT DURING PREL	BASIC	UPDT	RPLNG
GENERATE GROUND STATION COVERAGE	GND STA AC/LOS	COMPUTER	SALES	O	PROCESS TDRS DATA FOR ENHANCEMENT	Y	Y	Y	Y
GENERATE GROUND STATION COVERAGE	GND STA AC/LOS	COMPUTER	SALES	O	MERGE MISSION INDEPENDENT TARGETS	Y	Y	Y	Y
GENERATE RADIATION ENVIRONMENT	DETAIL EPHEM	COMPUTER	RADI2	I	GENERATE REQUIRED EPHEMERIS DATA FOR OUTPUT	Y	Y	Y	Y
GENERATE RADIATION ENVIRONMENT	RAD ENVIR	COMPUTER	RADI2	O	IMPOSE RADIATION CONSTRAINTS	Y	Y	Y	Y
IMPOSE RADIATION CONSTRAINTS	RAD ENVIR	COMPUTER	LTO	I	GENERATE RADITION ENVIRONMENT	Y	Y	Y	Y
IMPOSE RADIATION CONSTRAINTS	RADIATION CONSTRAINTS	MANUAL	LTO	I	PI DEVELOPED (RADIATION CONSTRAINTS)	Y	Y	Y	Y
IMPOSE RADIATION CONSTRAINTS	SAA AC/LOS	COMPUTER	LTO	O	CREATE COMMON FILE FOR ASTAR PROGRAM (DS)	Y	Y	Y	N
IMPOSE RADIATION CONSTRAINTS	SAA AC/LOS	COMPUTER	LTO	O	SCHEDULE SCIENCE OBSERVATIONS (DS)	Y	Y	Y	Y
IMPOSE RADIATION CONSTRAINTS	SAA AC/LOS	COMPUTER	LTO	O	COMBINE CONSTRAINTS TO DETERMINE CELESTIAL TARGETS AND MERGE FILES	Y	Y	Y	Y
IMPOSE RADIATION CONSTRAINTS	SAA AC/LOS	COMPUTER	LTO	O	MERGE MISSION INDEPENDENT TARGETS	Y	Y	Y	Y

ACTIVITY	INPUT/OUTPUT NAME	I/O FORM	SW ASSOC. WITH	TYPE	SOURCE/DESTINATION	CYCLES INPUT/OUTPUT DURING PREL	BASIC	UPDT	RPLNG
MERGE MISSION INDEPENDENT TARGETS	GND STA AC/LOS	COMPUTER	TARGEN	I	GENERATE GROUND STATION COVERAGE	Y	Y	Y	Y
MERGE MISSION INDEPENDENT TARGETS	MOON RISE/SET	COMPUTER	TARGEN	I	GENERATE MOON RISE/SET	Y	Y	Y	Y
MERGE MISSION INDEPENDENT TARGETS	SUN RISE/SET	COMPUTER	TARGEN	I	GENERATE SUN RISE/SET	Y	Y	Y	Y
MERGE MISSION INDEPENDENT TARGETS	PREL TDRS AC/LOS	COMPUTER	TARGEN	I	GENERATE PRELIMINARY TDRS COVERAGE	Y	Y	Y	N
MERGE MISSION INDEPENDENT TARGETS	SAA AC/LOS	COMPUTER	TARGEN	I	IMPOSE RADIATION CONSTRAINTS	Y	Y	Y	Y
MERGE MISSION INDEPENDENT TARGETS	PRINTOUTS OF MSN IND DATA	COMPUTER	TARGEN	O	DEVELOP GROSS MISSION TIMELINE	Y	Y	Y	Y
MERGE MISSION INDEPENDENT TARGETS	MSN IND TARGETS	COMPUTER	TARGEN	O	MERGE ALL EXPERIMENT TARGET FILES	Y	Y	Y	Y
MERGE MISSION INDEPENDENT TARGETS	MSN IND TARGETS	COMPUTER	TARGEN	O	GENERATE POCC MMU DATA SET	Y	Y	Y	Y
DEVELOP CELESTIAL TARGETS (NON-IPS MISSIONS)	CELESTIAL TARGETS	MANUAL	STAR	I	PI GENERATED (CELESTIAL TARGET REQMTS)	Y	Y	Y	N
DEVELOP CELESTIAL TARGETS (NON-IPS MISSIONS)	CEL TAR	COMPUTER	STAR	O	GENERATE CELESTIAL TARGET(S) ACQ/LOSS	Y	Y	Y	N

ACTIVITY	INPUT/OUTPUT NAME	I/O FORM	SW ASSOC. WITH	TYPE	SOURCE/DESTINATION	CYCLES INPUT/OUTPUT DURING			
						PREL	BASIC	UPDT	RPLNG
DEVELOP CELESTIAL TARGETS (IPS MISSIONS)	COO	COMPUTER	SUBCOO	I	PI DEVELOPED (CELESTIAL TARGETS OBSERVATION REQMTS)	Y	Y	Y	N
DEVELOP CELESTIAL TARGETS (IPS MISSIONS)	CEL TAR	COMPUTER	SUBCOO	O	GENERATE CELESTIAL TARGET(S) ACQ/LOSS	Y	Y	Y	N
DEVELOP CELESTIAL TARGETS (IPS MISSIONS)	SUBCOO	COMPUTER	SUBCOO	O	CREATE COMMON FILE FOR ASTAR PROGRAM (DS)	Y	Y	Y	N
DEVELOP CELESTIAL TARGETS (IPS MISSIONS)	SUBCOO	COMPUTER	SUBCOO	O	SCHEDULE SCIENCE OBSERVATIONS (DS)	Y	Y	Y	N
GENERATE CELESTIAL TARGET(S) ACQ/LOSS	ASCN NODE	COMPUTER	STAR	I	GENERATE REQUIRED EPHEMERIS DATA FOR OUTPUT	Y	Y	Y	Y
GENERATE CELESTIAL TARGET(S) ACQ/LOSS	CEL TAR	COMPUTER	STAR	I	DEVELOP CELESTIAL TARGETS (NON-IPS MISSION)	Y	Y	Y	N
GENERATE CELESTIAL TARGET(S) ACQ/LOSS	CEL TAR	COMPUTER	STAR	I	DEVELOP CELESTIAL TARGETS (IPS MISSION)	Y	Y	Y	N
GENERATE CELESTIAL TARGET(S) ACQ/LOSS	CEL TARGET(S) ELEV ANGLE CONSTS	MANUAL	STAR	I	PI GENERATED (CELESTIAL TARGET(S) ELEVATION ANGLE CONSTRAINTS)	Y	Y	Y	Y

ACTIVITY	INPUT/OUTPUT NAME	I/O FORM	SW ASSOC. WITH	TYPE	SOURCE/DESTINATION	CYCLES INPUT/OUTPUT DURING PREL	BASIC	UPDT	RPLNG
GENERATE CELESTIAL TARGET(S) ACQ/LOSS	CEL TAR AC/LOS	COMPUTER	STAR	O	COMBINE CONSTRAINTS TO DETERMINE CELESTIAL TARGETS AND MERGE FILES	Y	Y	Y	Y
COMBINE CONSTRAINTS TO DETERMINE CELESTIAL TARGETS AND MERGE FILES	CEL TAR AC/LOS	COMPUTER	TARGEN	I	GENERATE CELESTIAL TARGET(S) ACQ/LOSS	Y	Y	Y	Y
COMBINE CONSTRAINTS TO DETERMINE CELESTIAL TARGETS AND MERGE FILES	EARTH SHADOW	COMPUTER	TARGEN	I	GENERATE EARTH SHADOW ACQ/LOSS	Y	Y	Y	Y
COMBINE CONSTRAINTS TO DETERMINE CELESTIAL TARGETS AND MERGE FILES	SAA AC/LOS	COMPUTER	TARGEN	I	IMPOSE RADIATION CONSTRAINTS	Y	Y	Y	Y
COMBINE CONSTRAINTS TO DETERMINE CELESTIAL TARGETS AND MERGE FILES	CEL TARGETS	COMPUTER	TARGEN	O	MERGE ALL EXPERIMENT TARGET FILES	Y	Y	Y	Y
COMBINE CONSTRAINTS TO DETERMINE CELESTIAL TARGETS AND MERGE FILES	CEL TARGETS	COMPUTER	TARGEN	O	CREATE COMMON FILE FOR ASTAR PROGRAM (DS)	Y	Y	Y	Y
COMBINE CONSTRAINTS TO DETERMINE CELESTIAL TARGETS AND MERGE FILES	PRINTOUTS OF CELESTIAL DATA	COMPUTER	TARGEN	O	DEVELOP GROSS MISSION TIMELINE	Y	Y	Y	Y

ACTIVITY INPUT/OUTPUTS

ACTIVITY	INPUT/OUTPUT NAME	I/O FORM	SW ASSOC. WITH	TYPE	SOURCE/DESTINATION	CYCLES INPUT/OUTPUT DURING PREL	BASIC	UPDT	RPLNG
COMBINE CONSTRAINTS TO DETERMINE CELESTIAL TARGETS AND MERGE FILES	CEL TARGETS	COMPUTER	TARGEN	O	SCHEDULE SCIENCE OBSERVATIONS (DS)	Y	Y	Y	Y
COMPUTE DISTANCE FROM TANGENT POINT ON THE ORBITER TO SUN LINE-OF-SIGHT TO THE EARTH SURFACE	STATE VECTOR PRINTOUT	MANUAL	TANRAY	I	GENERATE STATE VECTOR	Y	Y	Y	N
COMPUTE DISTANCE FROM TANGENT POINT ON THE ORBITER TO SUN LINE-OF-SIGHT TO THE EARTH SURFACE	TANRAY EPHEM	COMPUTER	TANRAY	O	DEVELOP/APPLY CONSTRAINTS TO ATMOSPHERIC PHYSICS OBSERVATION PERIODS	Y	Y	Y	Y
DEVELOP/APPLY CONSTRAINTS TO ATMOSPHERIC PHYSICS OBSERVATION PERIODS	TANRAY EPHEM	COMPUTER	LTO	I	COMPUTE DISTANCE FROM TANGENT POINT ON THE ORBITER TO SUN LINE-OF-SIGHT TO EARTH SURFACE	Y	Y	Y	Y
DEVELOP/APPLY CONSTRAINTS TO ATMOSPHERIC PHYSICS OBSERVATION PERIODS	AT PHY CONSTS	COMPUTER	LTO	O	COMBINE CONSTRAINTS TO DETERMINE ATMOSPHERIC PHYSICS TARGETS	Y	Y	Y	Y
COMPUTE ORBIT TERMINATOR TARGETS	SUN RISE/SET	COMPUTER	TARGEN	I	GENERATE SUN RISE/SET	Y	Y	Y	Y
COMPUTE ORBIT TERMINATOR TARGETS	PI ORBIT TERM REQMTS	MANUAL	TARGEN	I	PI GENERATED (ORBIT TERMINATOR REQMTS)	Y	Y	Y	Y

ACTIVITY	INPUT/OUTPUT NAME	I/O FORM	SW ASSOC. WITH	TYPE	SOURCE/DESTINATION	CYCLES INPUT/OUTPUT DURING PREL	BASIC	UPDT	RPLNG
COMPUTE ORBIT TERMINATOR TARGETS	TERM AC/LOS	COMPUTER	TARGEN	O	COMBINE CONSTRAINTS TO DETERMINE ATMOSPHERIC PHYSICS TARGETS	Y	Y	Y	Y
COMBINE CONSTRAINTS TO DETERMINE ATMOSPHERIC PHYSICS TARGETS	TERM AC/LOS	COMPUTER	TARGEN	I	COMPUTE ORBIT TERMINATOR TARGETS	Y	Y	Y	Y
COMBINE CONSTRAINTS TO DETERMINE ATMOSPHERIC PHYSICS TARGETS	AT PHY CONSTS	COMPUTER	TARGEN	I	DEVELOP/APPLY CONSTRAINTS TO ATMOSPHERIC PHYSICS OBSERVATION PERIODS	Y	Y	Y	Y
COMBINE CONSTRAINTS TO DETERMINE ATMOSPHERIC PHYSICS TARGETS	PRINTOUTS OF ATMOS PHYSICS DATA	COMPUTER	TARGEN	O	DEVELOP GROSS MISSION TIMELINE	Y	Y	Y	Y
COMBINE CONSTRAINTS TO DETERMINE ATMOSPHERIC PHYSICS TARGETS	AT PHY TARGETS	COMPUTER	TARGEN	O	MERGE ALL EXPERIMENT TARGET FILES	Y	Y	Y	Y
COMPUTE SUN AZIMUTH AND ELEVATION FROM ORBITING VEHICLE WITH RESPECT TO SUN RISE/SET EVENTS	ASCN NODE	COMPUTER	ATMOS	I	GENERATE REQUIRED EPHEMERIS DATA FOR OUTPUT	N	N	N	Y

ACTIVITY INPUT/OUTPUTS

ACTIVITY	INPUT/OUTPUT NAME	I/O FORM	SW ASSOC. WITH	TYPE	SOURCE/DESTINATION	CYCLES INPUT/OUTPUT DURING PREL	BASIC	UPDT	RPLNG
COMPUTE SUN AZIMUTH AND ELEVATION FROM ORBITING VEHICLE WITH RESPECT TO SUN RISE/SET EVENTS	EARTH SHADOW	COMPUTER	ATMOS	I	GENERATE EARTH SHADOW ACQ/LOSS	N	N	N	Y
COMPUTE SUN AZIMUTH AND ELEVATION FROM ORBITING VEHICLE WITH RESPECT TO SUN RISE/SET EVENTS	ATMOS DESIRED VEHICLE ATTITUDE	MANUAL	ATMOS	I	PI (ATMOS EXP.) GENERATED (DESIRED VEHICLE ATTITUDE)	N	N	N	Y
COMPUTE SUN AZIMUTH AND ELEVATION FROM ORBITING VEHICLE WITH RESPECT TO SUN RISE/SET EVENTS	SUN AZ/ELV	COMPUTER	ATMOS	O	TO MMUM FOR REALTIME UPDATE TO THE EXP. DEP	N	N	N	Y
DEVELOP CONSTRAINTS FOR SOLAR VIEWING PERIODS	GND TRK	COMPUTER	LTO	I	GENERATE REQUIRED EPHEMERIS DATA FOR OUTPUT	Y	Y	Y	Y
DEVELOP CONSTRAINTS FOR SOLAR VIEWING PERIODS	SUN ELEV CONSTRAINTS (SOLAR)	MANUAL	LTO	I	PI GENERATED (SOLAR VIEWING SUN ELEVATION ANGLE CONSTRAINTS)	Y	Y	Y	Y
DEVELOP CONSTRAINTS FOR SOLAR VIEWING PERIODS	SOLAR CONSTS	COMPUTER	LTO	O	COMBINE CONSTRAINTS TO DETERMINE SOLAR TARGETS	Y	Y	Y	Y
COMBINE CONSTRAINTS TO DETERMINE SOLAR TARGETS	SUN RISE/SET	COMPUTER	TARGEN	I	GENERATE SUN RISE/SET	Y	Y	Y	Y

ACTIVITY	INPUT/OUTPUT NAME	I/O FORM	SW ASSOC. WITH	TYPE	SOURCE/DESTINATION	CYCLES INPUT/OUTPUT DURING PREL	BASIC	UPDT	RPLNG
COMBINE CONSTRAINTS TO DETERMINE SOLAR TARGETS	PREL TDRS AC/LOS	COMPUTER	TARGEN	I	GENERATE PRELIMINARY TDRS COVERAGE	Y	Y	Y	N
COMBINE CONSTRAINTS TO DETERMINE SOLAR TARGETS	SOLAR CONSTS	COMPUTER	TARGEN	I	DEVELOP CONSTRAINTS FOR SOLAR VIEWING PERIODS	Y	Y	Y	Y
COMBINE CONSTRAINTS TO DETERMINE SOLAR TARGETS	SOLAR TARGETS	COMPUTER	TARGEN	O	MERGE ALL EXPERIMENT TARGET FILES	Y	Y	Y	Y
COMBINE CONSTRAINTS TO DETERMINE SOLAR TARGETS	PRINTOUTS OF SOLAR DATA	COMPUTER	TARGEN	O	DEVELOP GROSS MISSION TIMELINE	Y	Y	Y	Y
CREATE EARTH SITE DEFINITION FILE	GROUND SITE POLYGONS	MANUAL	ESDAT	I	PI DEVELOPED (DESIRED GROUND OBSERVATION AREAS)	Y	Y	Y	N
CREATE EARTH SITE DEFINITION FILE	SITE DEF.	COMPUTER	ESDAT	O	GENERATE ACQ/LOSS OF GROUND SITE TARGET AREAS	Y	Y	Y	N
GENERATE ACQ/LOSS OF GROUND SITE TARGET AREAS	SITE DEF.	COMPUTER	ESAL	I	CREATE EARTH SITE DEFINITION FILE	Y	Y	Y	Y
GENERATE ACQ/LOSS OF GROUND SITE TARGET AREAS	ASCN NODE	COMPUTER	ESAL	I	GENERATE REQUIRED EPHEMERIS DATA FOR OUTPUT	Y	Y	Y	Y

ACTIVITY	INPUT/OUTPUT NAME	I/O FORM	SW ASSOC. WITH	TYPE	SOURCE/DESTINATION	CYCLES INPUT/OUTPUT DURING PREL	BASIC	UPDT	RPLNG
GENERATE ACQ/LOSS OF GROUND SITE TARGET AREAS	SITE AC/LOS	COMPUTER	ESAL	O	COMBINE CONSTRAINTS TO DETERMINE EARTH OBSERVATION TARGETS	Y	Y	Y	Y
DEVELOP/APPLY CONSTRAINTS TO EARTH OBSERVATION TARGETS	DETAIL EPHEM	COMPUTER	LTO	I	GENERATE REQUIRED EPHEMERIS DATA FOR OUTPUT	Y	Y	Y	Y
DEVELOP/APPLY CONSTRAINTS TO EARTH OBSERVATION TARGETS	GND TRK	COMPUTER	LTO	I	GENERATE REQUIRED EPHEMERIS DATA FOR OUTPUT	Y	Y	Y	Y
DEVELOP/APPLY CONSTRAINTS TO EARTH OBSERVATION TARGETS	EARTH OBSERV SUN ELEV CONSTS	MANUAL	LTO	I	PI GENERATED (EARTH OBSERVATION SUN ELEVATION CONSTRAINTS)	Y	Y	Y	N
DEVELOP/APPLY CONSTRAINTS TO EARTH OBSERVATION TARGETS	OBS CONSTS	COMPUTER	LTO	O	COMBINE CONSTRAINTS TO DETERMINE EARTH OBSERVATION TARGETS	Y	Y	Y	Y
COMBINE CONSTRAINTS TO DETERMINE EARTH OBSERVATION TARGETS	SITE AC/LOS	COMPUTER	TARGEN	I	GENERATE ACQ/LOSS OF GROUND SITE TARGET AREAS	Y	Y	Y	Y
COMBINE CONSTRAINTS TO DETERMINE EARTH OBSERVATION TARGETS	OBS CONSTS	COMPUTER	TARGEN	I	DEVELOP/APPLY CONSTRAINTS TO EARTH OBSERVATION TARGETS	Y	Y	Y	Y
COMBINE CONSTRAINTS TO DETERMINE EARTH OBSERVATION TARGETS	PRINTOUTS OF EARTH OBSERV DATA	COMPUTER	TARGEN	O	DEVELOP GROSS MISSION TIMELINE	Y	Y	Y	Y

ACTIVITY INPUT/OUTPUTS

ACTIVITY	INPUT/OUTPUT NAME	I/O FORM	SW ASSOC. WITN	TYPE	SOURCE/DESTINATION	CYCLES INPUT/OUTPUT DURING PREL	BASIC	UPDT	RPLNG
COMBINE CONSTRAINTS TO DETERMINE EARTH OBSERVATION TARGETS	EARTH TARGETS	COMPUTER	TARGEN	O	MERGE ALL EXPERIMENT TARGET FILES	Y	Y	Y	Y
COMPUTE ORIENTATION AND STRENGTH OF MAGNETIC FIELD IN THE ORBITER COORDINATE SYSTEM	ASCN NODE	COMPUTER	BORB	I	GENERATE REQUIRED EPHEMERIS DATA FOR OUTPUT	Y	Y	Y	Y
COMPUTE ORIENTATION AND STRENGTH OF MAGNETIC FIELD IN THE ORBITER COORDINATE SYSTEM	ATT TL	COMPUTER	BORB	I	EDIT CURRENT ATTITUDE T/L TO INCORPORATE STS OR OTHER REQNTS	Y	Y	Y	Y
COMPUTE ORIENTATION AND STRENGTH OF MAGNETIC FIELD IN THE ORBITER COORDINATE SYSTEM	PREL ATT TL	COMPUTER	BORB	I	DEVELOP PRELIMINARY ATTITUDE TIMELINE	Y	Y	Y	N
COMPUTE ORIENTATION AND STRENGTH OF MAGNETIC FIELD IN THE ORBITER COORDINATE SYSTEM	STATE VECTOR PRINTOUT	MANUAL	BORB	I	GENERATE STATE VECTOR	Y	Y	Y	Y
COMPUTE ORIENTATION AND STRENGTH OF MAGNETIC FIELD IN THE ORBITER COORDINATE SYSTEM	PL PHYSICS DESIRED VEH. ATTITUDE	MANUAL	BORB	I	PI SUPPLIED DESIRED VEH. ATTITUDE/EL25 DEVELOPED	Y	Y	Y	Y

ACTIVITY	INPUT/OUTPUT NAME	I/O FORM	SW ASSOC. WITH	TYPE	SOURCE/DESTINATION	CYCLES INPUT/OUTPUT DURING PREL	BASIC	UPDT	RPLNG
COMPUTE ORIENTATION AND STRENGTH OF MAGNETIC FIELD IN THE ORBITER COORDINATE SYSTEM	BORB PAR.	COMPUTER	BORB	O	DEVELOP/APPLY CONSTRAINTS TO BORB PARAMETERS	Y	Y	Y	Y
DEVELOP/APPLY CONSTRAINTS TO BORB PARAMETERS	BORB PAR.	COMPUTER	LTO	I	COMPUTE ORIENTATION AND STRENGTH OF MAGNETIC FIELD IN THE ORBITER COORDINATE SYSTEM	Y	Y	Y	Y
DEVELOP/APPLY CONSTRAINTS TO BORB PARAMETERS	BORB CONSTRAINTS	MANUAL	LTO	I	PI GENERATED (BORB CONSTRAINTS)	Y	Y	Y	Y
DEVELOP/APPLY CONSTRAINTS TO BORB PARAMETERS	BORB CONSTS	COMPUTER	LTO	O	COMBINE CONSTRAINTS TO DETERMINE PLASMA PHYSICS TARGETS	Y	Y	Y	Y
GENERATE HEMISPHERE OPPORTUNITIES	GND TRK	COMPUTER	LTO	I	GENERATE REQUIRED EPHEMERIS DATA FOR OUTPUT	Y	Y	Y	Y
GENERATE HEMISPHERE OPPORTUNITIES	LATITUDE CONSTRAINTS	MANUAL	LTO	I	PI DEVELOPED (HEMISPHERE LATITUDE CONSTRAINTS)	Y	Y	Y	Y
GENERATE HEMISPHERE OPPORTUNITIES	HEMSPR CONSTS	COMPUTER	LTO	O	COMBINE CONSTRAINTS TO DETERMINE PLASMA PHYSICS TARGETS	Y	Y	Y	Y

ACTIVITY	INPUT/OUTPUT NAME	I/O FORM	SW ASSOC. WITH	TYPE	SOURCE/DESTINATION	CYCLES INPUT/OUTPUT DURING PREL	BASIC	UPDT	RPLNG
COMBINE CONSTRAINTS TO DETERMINE PLASMA PHYSICS TARGETS	HEMSPR CONSTS	COMPUTER	TARGEN	I	GENERATE HEMISPHERE OPPORTUNITIES	Y	Y	Y	Y
COMBINE CONSTRAINTS TO DETERMINE PLASMA PHYSICS TARGETS	BORB CONSTS	COMPUTER	TARGEN	I	DEVELOP/APPLY CONSTRAINTS TO BORB PARAMETERS	Y	Y	Y	Y
COMBINE CONSTRAINTS TO DETERMINE PLASMA PHYSICS TARGETS	PRINTOUTS OF PLASMA PHYSICS DATA	COMPUTER	TARGEN	O	DEVELOP GROSS MISSION TIMELINE	Y	Y	Y	Y
COMBINE CONSTRAINTS TO DETERMINE PLASMA PHYSICS TARGETS	PL PHY TARGETS	COMPUTER	TARGEN	O	MERGE ALL EXPERIMENT TARGET FILES	Y	Y	Y	Y
MERGE ALL EXPERIMENT TARGET FILES	AT PHY TARGETS	COMPUTER	TARGEN	I	COMBINE CONSTRAINTS TO DETERMINE ATMOSPHERIC PHYSICS TARGETS	Y	Y	Y	Y
MERGE ALL EXPERIMENT TARGET FILES	EARTH TARGETS	COMPUTER	TARGEN	I	COMBINE CONSTRAINTS TO DETERMINE EARTH OBSERVATION TARGETS	Y	Y	Y	Y
MERGE ALL EXPERIMENT TARGET FILES	SOLAR TARGETS	COMPUTER	TARGEN	I	COMBINE CONSTRAINTS TO DETERMINE SOLAR TARGETS	Y	Y	Y	Y
MERGE ALL EXPERIMENT TARGET FILES	PL PHY TARGETS	COMPUTER	TARGEN	I	COMBINE CONSTRAINTS TO DETERMINE PLASMA PHYSICS TARGETS	Y	Y	Y	Y

ACTIVITY	INPUT/OUTPUT NAME	I/O FORM	SW ASSOC. WITH	TYPE	SOURCE/DESTINATION	CYCLES INPUT/OUTPUT DURING PREL	BASIC	UPDT	RPLNG
MERGE ALL EXPERIMENT TARGET FILES	MSN IND TARGETS	COMPUTER	TARGEN	I	MERGE MISSION INDEPENDENT TARGETS	Y	Y	Y	Y
MERGE ALL EXPERIMENT TARGET FILES	CEL TARGETS	COMPUTER	TARGEN	I	COMBINE CONSTRAINTS TO DETERMINE CELESTIAL TARGETS AND MERGE FILES	Y	Y	Y	Y
MERGE ALL EXPERIMENT TARGET FILES	MSN TARGETS	COMPUTER	TARGEN	O	CREATE ESS TARGET FILE	Y	Y	Y	Y
MERGE ALL EXPERIMENT TARGET FILES	MSN TARGETS	COMPUTER	TARGEN	O	GENERATE PCAP CHARTS	Y	Y	Y	Y
MERGE ALL EXPERIMENT TARGET FILES	MSN TARGETS	COMPUTER	TARGEN	O	GENERATE PTS CHARTS	Y	Y	Y	Y
PERFORM PARAMETRIC ANALYSIS TO DESIGN/DEVELOP CO-ORBITING TRAJECTORIES THAT SATISFY OBJECTIVES AND CONSTRAINTS	BASIC CO-ORBITING REQMTS	MANUAL	RELMO	I	ORBIT ANALYSIS DEVELOPED (EL25)	Y	Y	Y	N
PERFORM PARAMETRIC ANALYSIS TO DESIGN/DEVELOP CO-ORBITING TRAJECTORIES THAT SATISFY OBJECTIVES AND CONSTRAINTS	STS REQMTS/CONSTRAINTS	MANUAL	RELMO	I	STS CTR DEVELOPED (STS REQMTS/CONSTRAINTS)	Y	Y	Y	N

ACTIVITY INPUT/OUTPUTS

ACTIVITY	INPUT/OUTPUT NAME	I/O FORM	SW ASSOC. WITH	TYPE	SOURCE/DESTINATION	CYCLES INPUT/OUTPUT DURING			
						PREL	BASIC	UPDT	RPLNG
PERFORM PARAMETRIC ANALYSIS TO DESIGN/DEVELOP CO-ORBITING TRAJECTORIES THAT SATISFY OBJECTIVES AND CONSTRAINTS	PI REQMTS/CONSTRAINTS	MANUAL	RELMO	I	PI DEVELOPED (CO-ORBITING REQMTS)	Y	Y	Y	N
PERFORM PARAMETRIC ANALYSIS TO DESIGN/DEVELOP CO-ORBITING TRAJECTORIES THAT SATISFY OBJECTIVES AND CONSTRAINTS	INPUTS TO MISSION PLANNING	MANUAL	RELMO	O	DEVELOP GROSS MISSION TIMELINE	Y	Y	Y	N
DEVELOP GROSS MISSION TIMELINE	MISSION PROFILE CONSIDERATIONS	MANUAL	NONE	I	MSN MANAGEMENT, IWG, PI'S, ANALYSTS	Y	Y	Y	N
DEVELOP GROSS MISSION TIMELINE	MSN EXP OPPORTUNITIES DATA	MANUAL	NONE	I	EXPERIMENT OPPORTUNITIES GENERATION	Y	Y	Y	N
DEVELOP GROSS MISSION TIMELINE	MGMT AGREEMENT ON GROSS MSN T/L	MANUAL	NONE	O	DEVELOP PRELIMINARY ATTITUDE TIMELINE	Y	Y	Y	N
DEVELOP GROSS MISSION TIMELINE	MGMT AGREEMENT ON GROSS MSN T/L	MANUAL	NONE	O	CREATE RESERVE PERIOD FILE (DS)	Y	Y	Y	N
DEVELOP GROSS MISSION TIMELINE	MGMT AGREEMENT ON GROSS MSN T/L	MANUAL	NONE	O	GENERATE MISSION TIMELINE	Y	Y	Y	N
DEVELOP PRELIMINARY ATTITUDE TIMELINE	MGMT AGREEMENT ON GROSS MSN T/L	MANUAL	CAVINP	I	DEVELOP GROSS MISSION TIMELINE	Y	Y	Y	N

ACTIVITY	INPUT/OUTPUT NAME	I/O FORM	SW ASSOC. WITH	TYPE	SOURCE/DESTINATION	CYCLES INPUT/OUTPUT DURING PREL	BASIC	UPDT	RPLNG
DEVELOP PRELIMINARY ATTITUDE TIMELINE	PREL ATT TL	COMPUTER	CAVINP	O	GENERATE PRELIMINARY TDRS COVERAGE	Y	Y	Y	N
DEVELOP PRELIMINARY ATTITUDE TIMELINE	PREL ATT TL	COMPUTER	CAVINP	O	COMPUTE ORIENTATION AND STRENGTH OF MAGNETIC FIELD IN THE ORBITER COORDINATE SYSTEM	Y	Y	Y	N
DEVELOP PRELIMINARY ATTITUDE TIMELINE	PREL ATT TL	COMPUTER	CAVINP	O	EDIT CURRENT ATTITUDE T/L TO INCORPORATE STS OR OTHER REQMTS	Y	Y	Y	N
CREATE COMMON FILE FOR ASTAR PROGRAM (DS)	CEL TARGETS	COMPUTER	READPI	I	COMBINE CONSTRAINTS TO DETERMINE CELESTIAL TARGETS AND MERGE FILES	Y	Y	Y	N
CREATE COMMON FILE FOR ASTAR PROGRAM (DS)	TIME GOAL	COMPUTER	READPI	I	PI DEVELOPED (DESIRED TARGET OBSERVATION TIMES)	Y	Y	Y	N
CREATE COMMON FILE FOR ASTAR PROGRAM (DS)	SUBCOO	COMPUTER	READPI	I	DEVELOP CELESTIAL TARGETS (IPS MISSION)	Y	Y	Y	N
CREATE COMMON FILE FOR ASTAR PROGRAM (DS)	EARTH SHADOW	COMPUTER	READPI	I	GENERATE EARTH SHADOW ACQ/LOSS	Y	Y	Y	N
CREATE COMMON FILE FOR ASTAR PROGRAM (DS)	SAA AC/LOS	COMPUTER	READPI	I	IMPOSE RADIATION CONSTRAINTS	Y	Y	Y	N

ACTIVITY	INPUT/OUTPUT NAME	I/O FORM	SW ASSOC. WITH	TYPE	SOURCE/DESTINATION	CYCLES INPUT/OUTPUT DURING			
						PREL	BASIC	UPDT	RPLNG
CREATE COMMON FILE FOR ASTAR PROGRAM (DS)	COO	COMPUTER	READPI	I	PI DEVELOPED (CELESTIAL TARGETS OBSERVATION REQMTS)	Y	Y	Y	N
CREATE COMMON FILE FOR ASTAR PROGRAM (DS)	ANG'LR DIST'CE	COMPUTER	READPI	O	SCHEDULE SCIENCE OBSERVATIONS (DS)	Y	Y	Y	N
CREATE COMMON FILE FOR ASTAR PROGRAM (DS)	READPI	COMPUTER	READPI	O	SCHEDULE SCIENCE OBSERVATIONS (DS)	Y	Y	Y	N
CREATE RESERVE PERIOD FILE (DS)	RESERVE PERIODS CONSIDERATIONS	MANUAL	EDT	I	DEVELOP GROSS MISSION TIMELINE	Y	Y	Y	N
CREATE RESERVE PERIOD FILE (DS)	RESERVE PERIODS	COMPUTER	EDT	O	SCHEDULE SCIENCE OBSERVATIONS (DS)	Y	Y	Y	N
SCHEDULE SCIENCE OBSERVATIONS (DS)	SUBCOO	COMPUTER	ASTAR	I	DEVELOP CELESTIAL TARGETS (IPS MISSION)	Y	Y	Y	N
SCHEDULE SCIENCE OBSERVATIONS (DS)	CEL TARGETS	COMPUTER	ASTAR	I	COMBINE CONSTRAINTS TO DETERMINE CELESTIAL TARGETS AND MERGE FILES	Y	Y	Y	Y
SCHEDULE SCIENCE OBSERVATIONS (DS)	RESERVE PERIODS	COMPUTER	ASTAR	I	CREATE RESERVE PERIOD FILE (DS)	Y	Y	Y	N
SCHEDULE SCIENCE OBSERVATIONS (DS)	READPI	COMPUTER	ASTAR	I	CREATE COMMON FILE FOR ASTAR PROGRAM (DS)	Y	Y	Y	Y

ACTIVITY	INPUT/OUTPUT NAME	I/O FORM	SW ASSOC. WITH	TYPE	SOURCE/DESTINATION	CYCLES INPUT/OUTPUT DURING			
						PREL	BASIC	UPDT	RPLNG
SCHEDULE SCIENCE OBSERVATIONS (DS)	ANG'LR DIST'CE	COMPUTER	ASTAR	I	CREATE COMMON FILE FOR ASTAR PROGRAM (DS)	Y	Y	Y	Y
SCHEDULE SCIENCE OBSERVATIONS (DS)	EARTH SHADOW	COMPUTER	ASTAR	I	GENERATE EARTH SHADOW ACQ/LOSS	Y	Y	Y	Y
SCHEDULE SCIENCE OBSERVATIONS (DS)	SAA AC/LOS	COMPUTER	ASTAR	I	IMPOSE RADIATION CONSTRAINTS	Y	Y	Y	Y
SCHEDULE SCIENCE OBSERVATIONS (DS)	COO	COMPUTER	ASTAR	I	PI DEVELOPED (CELESTIAL TARGETS OBSERVATION REQMTS)	Y	Y	Y	N
SCHEDULE SCIENCE OBSERVATIONS (DS)	SCIENCE SCHED'LE	COMPUTER	ASTAR	O	GENERATE CANDIDATE STELLAR GUIDE STARS (DS)	Y	Y	Y	N
SCHEDULE SCIENCE OBSERVATIONS (DS)	SCIENCE SCHED'LE	COMPUTER	ASTAR	O	GENERATE IPS POINTING DATA (DS)	Y	Y	Y	Y
SCHEDULE SCIENCE OBSERVATIONS (DS)	SCIENCE SCHED'LE	COMPUTER	ASTAR	O	GENERATE JOINT OPERATIONS TARGET FILE (DS)	Y	Y	Y	Y
SCHEDULE SCIENCE OBSERVATIONS (DS)	SCIENCE SCHED'LE	COMPUTER	ASTAR	O	CREATE ESS TARGET FILE	Y	Y	Y	Y
SCHEDULE SCIENCE OBSERVATIONS (DS)	SCIENCE SCHED'LE	COMPUTER	ASTAR	O	GENERATE MANEUVER TIMELINE (DS)	Y	Y	Y	Y
SCHEDULE SCIENCE OBSERVATIONS (DS)	SCIENCE SCHED'LE	COMPUTER	ASTAR	O	SELECT IPS ROLL ANGLES (DS)	Y	Y	Y	Y

ACTIVITY INPUT/OUTPUTS

ACTIVITY	INPUT/OUTPUT NAME	I/O FORM	SW ASSOC. WITH	TYPE	SOURCE/DESTINATION	CYCLES INPUT/OUTPUT DURING PREL	BASIC	UPDT	RPLNG
GENERATE ATTITUDE TIMELINE	KEYW'RD	COMPUTER	KEYGEN	I	DEVELOPED AS PART OF THIS SUBTASK BY ORBIT ANALYSIS ENGINEERS	Y	Y	Y	Y
GENERATE ATTITUDE TIMELINE	MVR TL	COMPUTER	KEYGEN	I	GENERATE MISSION TIMELINE	Y	Y	Y	Y
GENERATE ATTITUDE TIMELINE	ATT TL (NDF)	COMPUTER	KEYGEN	O	GENERATE ORBITER POINTING DATA	Y	Y	Y	Y
GENERATE ATTITUDE TIMELINE	ATT TL	COMPUTER	KEYGEN	O	EDIT CURRENT ATTITUDE T/L TO INCORPORATE STS OR OTHER REQMTS	Y	Y	Y	Y
EDIT CURRENT ATTITUDE T/L TO INCORPORATE STS OR OTHER REQMTS	PREL ATT TL	COMPUTER	CAVINP	I	DEVELOP PRELIMINARY ATTITUDE TIMELINE	Y	Y	Y	N
EDIT CURRENT ATTITUDE T/L TO INCORPORATE STS OR OTHER REQMTS	ATT TL	COMPUTER	CAVINP	I	GENERATE ATTITUDE TIMELINE	Y	Y	Y	Y
EDIT CURRENT ATTITUDE T/L TO INCORPORATE STS OR OTHER REQMTS	ATTITUDE UPDATES	MANUAL	CAVINP	I	FINALIZE MISSION TIMELINE	Y	Y	Y	Y
EDIT CURRENT ATTITUDE T/L TO INCORPORATE STS OR OTHER REQMTS	ATTITUDE UPDATES	MANUAL	CAVINP	I	GENERATE MISSION TIMELINE	Y	Y	Y	Y

ACTIVITY	INPUT/OUTPUT NAME	I/O FORM	SW ASSOC. WITH	TYPE	SOURCE/DESTINATION	CYCLES INPUT/OUTPUT DURING			
						PREL	BASIC	UPDT	RPLNG
EDIT CURRENT ATTITUDE T/L TO INCORPORATE STS OR OTHER REQMTS	ATT TL	COMPUTER	CAVINP	O	GENERATE POCC CHECKLIST AND COMMAND TIMELINE	N	Y	Y	Y
EDIT CURRENT ATTITUDE T/L TO INCORPORATE STS OR OTHER REQMTS	ATT TL	COMPUTER	CAVINP	O	GENERATE PTS CHARTS	Y	Y	Y	Y
EDIT CURRENT ATTITUDE T/L TO INCORPORATE STS OR OTHER REQMTS	ATT TL	COMPUTER	CAVINP	O	GENERATE TDRS COVERAGE	Y	Y	Y	Y
EDIT CURRENT ATTITUDE T/L TO INCORPORATE STS OR OTHER REQMTS	ATT TL	COMPUTER	CAVINP	O	COMPUTE ORIENTATION AND STRENGTH OF MAGNETIC FIELD IN THE ORBITER COORDINATE SYSTEM	Y	Y	Y	Y
EDIT CURRENT ATTITUDE T/L TO INCORPORATE STS OR OTHER REQMTS	ATT TL	COMPUTER	CAVINP	O	GENERATE PCAP CHARTS	Y	Y	Y	Y
EDIT CURRENT ATTITUDE T/L TO INCORPORATE STS OR OTHER REQMTS	ATT TL	COMPUTER	CAVINP	O	CREATE ESS TARGET FILE	Y	Y	Y	Y
GENERATE MANEUVER TIMELINE (DS)	SCIENCE SCHED'LE	COMPUTER	PAAC	I	SCHEDULE SCIENCE OBSERVATIONS (DS)	Y	Y	Y	Y

ACTIVITY	INPUT/OUTPUT NAME	I/O FORM	SW ASSOC. WITH	TYPE	SOURCE/DESTINATION	CYCLES INPUT/OUTPUT DURING PREL	BASIC	UPDT	RPLNG
GENERATE MANEUVER TIMELINE (DS)	MVR TL	COMPUTER	PAAC	O	GENERATE ATTITUDE TIMELINE (DS)	Y	Y	Y	Y
GENERATE MANEUVER TIMELINE (DS)	KEYW'RD	COMPUTER	PAAC	O	GENERATE ATTITUDE TIMELINE (DS)	Y	Y	Y	Y
GENERATE ATTITUDE TIMELINE (DS)	MVR TL	COMPUTER	KEYGEN	I	GENERATE MANEUVER TIMELINE (DS)	Y	Y	Y	Y
GENERATE ATTITUDE TIMELINE (DS)	KEYW'RD	COMPUTER	KEYGEN	I	GENERATE MANEUVER TIMELINE (DS)	Y	Y	Y	Y
GENERATE ATTITUDE TIMELINE (DS)	ATT TL	COMPUTER	KEYGEN	O	EDIT TO INCORPORATE STS OR OTHER REQMTS (DS)	Y	Y	Y	Y
GENERATE ATTITUDE TIMELINE (DS)	ATT TL (NDF)	COMPUTER	KEYGEN	O	GENERATE ORBITER POINTING DATA	Y	Y		Y
EDIT TO INCORPORATE STS OR OTHER REQMTS (DS)	ATT TL	COMPUTER	CAVINP	I	GENERATE ATTITUDE TIMELINE (DS)	Y	Y	Y	Y
EDIT TO INCORPORATE STS OR OTHER REQMTS (DS)	ATTITUDE UPDATES	MANUAL	CAVINP	I	GENERATE MISSION TIMELINE	Y	Y	Y	Y
EDIT TO INCORPORATE STS OR OTHER REQMTS (DS)	ATTITUDE UPDATES	MANUAL	CAVINP	I	FINALIZE MISSION TIMELINE	Y	Y	Y	Y
EDIT TO INCORPORATE STS OR OTHER REQMTS (DS)	ATT TL	COMPUTER	CAVINP	O	GENERATE PTS CHARTS	Y	Y	Y	Y

ACTIVITY	INPUT/OUTPUT NAME	I/O FORM	SW ASSOC. WITH	TYPE	SOURCE/DESTINATION	CYCLES INPUT/OUTPUT DURING PREL	BASIC	UPDT	RPLNG
EDIT TO INCORPORATE STS OR OTHER REQMTS (DS)	ATT TL	COMPUTER	CAVINP	O	GENERATE TDRS COVERAGE	Y	Y	Y	Y
EDIT TO INCORPORATE STS OR OTHER REQMTS (DS)	ATT TL	COMPUTER	CAVINP	O	GENERATE POCC CHECKLIST AND COMMAND TIMELINE	N	Y	Y	Y
EDIT TO INCORPORATE STS OR OTHER REQMTS (DS)	ATT TL	COMPUTER	CAVINP	O	CREATE ESS TARGET FILE	Y	Y	Y	Y
EDIT TO INCORPORATE STS OR OTHER REQMTS (DS)	ATT TL	COMPUTER	CAVINP	O	GENERATE PCAP CHARTS	Y	Y	Y	Y
GENERATE ORBITER POINTING DATA	ATT TL (NDF)	COMPUTER	PROCAM	I	GENERATE ATTITUDE TIMELINE (DS)	Y	Y	Y	Y
GENERATE ORBITER POINTING DATA	ATT TL (NDF)	COMPUTER	PROCAM	I	GENERATE ATTITUDE TIMELINE	Y	Y	Y	Y
GENERATE ORBITER POINTING DATA	DETAIL EPHEM	COMPUTER	PROCAM	I	GENERATE REQUIRED EPHEMERIS DATA FOR OUTPUT	Y	Y	Y	Y
GENERATE ORBITER POINTING DATA	PROCAM	COMPUTER	PROCAM	O	GENERATE PTS CHARTS	Y	Y	Y	Y
GENERATE ORBITER POINTING DATA	PROCAM	COMPUTER	PROCAM	O	DEVELOP STRAY LIGHT CONSTRAINTS	Y	Y	Y	Y
GENERATE ORBITER POINTING DATA	PROCAM	COMPUTER	PROCAM	O	GENERATE IPS POINTING DATA (DS)	Y	Y	Y	Y

ACTIVITY	INPUT/OUTPUT NAME	I/O FORM	SW ASSOC. WITH	TYPE	SOURCE/DESTINATION	CYCLES INPUT/OUTPUT DURING PREL	BASIC	UPDT	RPLNG
GENERATE ORBITER POINTING DATA	PROCAM	COMPUTER	PROCAM	O	SELECT IPS ROLL ANGLES (DS)	Y	Y	Y	Y
GENERATE TDRS COVERAGE	ORBITER OCCULT	COMPUTER	CAVINP	I	JSC	Y	Y	Y	N
GENERATE TDRS COVERAGE	ASCN NODE	COMPUTER	CAVINP	I	GENERATE REQUIRED EPHEMERIS DATA FOR OUTPUT	Y	Y	Y	Y
GENERATE TDRS COVERAGE	ATT TL	COMPUTER	CAVINP	I	EDIT CURRENT ATTITUDE T/L TO INCORPORATE STS OR OTHER REQMTS	Y	Y	Y	Y
GENERATE TDRS COVERAGE	ATT TL	COMPUTER	CAVINP	I	EDIT TO INCORPORATE STS OR OTHER REQMTS (DS)	Y	Y	Y	Y
GENERATE TDRS COVERAGE	TDRS AC/LOS	COMPUTER	CAVINP	O	GENERATE PCAP CHARTS	N	Y	Y	Y
GENERATE TDRS COVERAGE	TDRS AC/LOS	COMPUTER	CAVINP	O	CREATE ESS TARGET FILE	Y	Y	Y	Y
GENERATE TDRS COVERAGE	TDRS AC/LOS	COMPUTER	CAVINP	O	GENERATE PTS CHARTS	Y	Y	Y	Y
GENERATE TDRS COVERAGE	TDRS AC/LOS	COMPUTER	CAVINP	O	PROCESS TDRS DATA FOR ENHANCEMENT	Y	Y	Y	Y
PROCESS TDRS DATA FOR ENHANCEMENT	TDRS AC/LOS	COMPUTER	TARGEN	I	GENERATE TDRS COVERAGE	Y	Y	Y	Y

ACTIVITY	INPUT/OUTPUT NAME	I/O FORM	SW ASSOC. WITH	TYPE	SOURCE/DESTINATION	CYCLES INPUT/OUTPUT DURING			
						PREL	BASIC	UPDT	RPLNG
PROCESS TDRS DATA FOR ENHANCEMENT	GND STA AC/LOS	COMPUTER	TARGEN	I	GENERATE GROUND STATION COVERAGE	Y	Y	Y	Y
PROCESS TDRS DATA FOR ENHANCEMENT	COMM AC/LOS	COMPUTER	TARGEN	O	GENERATE MISSION WINDOWS	Y	Y	Y	Y
PROCESS TDRS DATA FOR ENHANCEMENT	COMM AC/LOS	COMPUTER	TARGEN	O	UPDATE OR ENHANCE EXISTING SCHEDULE	Y	Y	Y	Y
PROCESS TDRS DATA FOR ENHANCEMENT	COMM AC/LOS	COMPUTER	TARGEN	O	GENERATE DATA FLOW REPORTS	Y	Y	Y	Y
PROCESS TDRS DATA FOR ENHANCEMENT	COMM AC/LOS	COMPUTER	TARGEN	O	VERIFY DATA FLOW SCHEDULES	Y	Y	Y	Y
PROCESS TDRS DATA FOR ENHANCEMENT	COMM AC/LOS	COMPUTER	TARGEN	O	GENERATE POCC MMU DATA SET	Y	Y	Y	Y
GENERATE POCC MMU DATA SET	COMM AC/LOS	COMPUTER	PMDSG	I	PROCESS TDRS DATA FOR ENHANCEMENT	Y	Y	Y	Y
GENERATE POCC MMU DATA SET	ASCN NODE	COMPUTER	PMDSG	I	GENERATE REQUIRED EPHEMERIS DATA FOR OUTPUT	Y	Y	Y	Y
GENERATE POCC MMU DATA SET	MSN IND TARGETS	COMPUTER	PMDSG	I	MERGE MISSION INDEPENDENT TARGETS	Y	Y	Y	Y
GENERATE POCC MMU DATA SET	PRINTOUTS OF MMU DATA SET	COMPUTER	PMDSG	O	MANUAL VERIFICATION OF MMU DATA SET	Y	Y	Y	Y
GENERATE POCC MMU DATA SET	MMU DAT SET	COMPUTER	PMDSG	O	MMU LOAD INPUT DEVELOPMENT	Y	Y	Y	Y

ACTIVITY	INPUT/OUTPUT NAME	I/O FORM	SW ASSOC. WITH	TYPE	SOURCE/DESTINATION	CYCLES INPUT/OUTPUT DURING PREL	BASIC	UPDT	RPLNG
GENERATE CANDIDATE SOLAR GUIDE STARS	SKYMAP DATBSE	COMPUTER	SCATGEN	I	MSFC DEVELOPED	Y	Y	Y	N
GENERATE CANDIDATE SOLAR GUIDE STARS	LAUNCH WINDOW/LAUNCH TIME DATA	MANUAL	SCATGEN	I	LAUNCH WINDOW/LAUNCH TIME SELECTION	Y	Y	Y	N
GENERATE CANDIDATE SOLAR GUIDE STARS	CAND GSTAR	COMPUTER	SCATGEN	O	GENERATE SOLAR OBJECTIVE LOADS	Y	Y	Y	N
GENERATE CANDIDATE SOLAR GUIDE STARS	PRINTOUTS OF CAND GUIDE STARS	COMPUTER	SCATGEN	O	DEVELOP STRAY LIGHT CONSTRAINTS	Y	Y	Y	N
DEVELOP STRAY LIGHT CONSTRAINTS	PROCAM	COMPUTER	ASTRO	I	GENERATE ORBITER POINTING DATA	Y	Y	Y	N
DEVELOP STRAY LIGHT CONSTRAINTS	PRINTOUTS OF CAND GUIDE STARS	MANUAL	ASTRO	I	GENERATE CANDIDATE SOLAR GUIDE STARS	Y	Y	Y	N
DEVELOP STRAY LIGHT CONSTRAINTS	PRINTOUTS OF STRAY LIGHT DATA	COMPUTER	ASTRO	O	CHOOSE SOLAR GUIDE STARS	Y	Y	Y	N
CHOOSE SOLAR GUIDE STARS	PRINTOUTS OF STRAY LIGHT DATA	MANUAL	NONE	I	DEVELOP STRAY LIGHT CONSTRAINTS	Y	Y	Y	N
CHOOSE SOLAR GUIDE STARS	GUIDE STAR CHOICES	MANUAL	NONE	O	GENERATE SOLAR OBJECTIVE LOADS	Y	Y	Y	N
GENERATE SOLAR OBJECTIVE LOADS	CAND GSTAR	COMPUTER	SCATGEN	I	GENERATE CANDIDATE SOLAR GUIDE STARS	Y	Y	Y	N
GENERATE SOLAR OBJECTIVE LOADS	GUIDE STAR CHOICES	MANUAL	SCATGEN	I	CHOOSE SOLAR GUIDE STARS	Y	Y	Y	N

ACTIVITY	INPUT/OUTPUT NAME	I/O FORM	SW ASSOC. WITH	TYPE	SOURCE/DESTINATION	CYCLES INPUT/OUTPUT DURING PREL	BASIC	UPDT	RPLNG
GENERATE SOLAR OBJECTIVE LOADS	SOLAR OBJ LOAD SUMMARY	COMPUTER	SCATGEN	O	USED FOR SOLAR OBJECTIVE LOAD VERIFICATION AND GENERAL INFORMATION	Y	Y	Y	N
GENERATE SOLAR OBJECTIVE LOADS	OBJ LOAD	COMPUTER	SCATGEN	O	MMU LOAD INPUT DEVELOPMENT	Y	Y	Y	N
GENERATE CANDIDATE STELLAR GUIDE STARS (DS)	COO	COMPUTER	GSOLP	I	PI DEVELOPED (CELESTIAL TARGETS OBSERVATION REQMTS)	Y	Y	Y	N
GENERATE CANDIDATE STELLAR GUIDE STARS (DS)	SCIENCE SCHED'LE	COMPUTER	GSOLP	I	SCHEDULE SCIENCE OBSERVATIONS (DS)	Y	Y	Y	N
GENERATE CANDIDATE STELLAR GUIDE STARS (DS)	SKYMAP DATBSE	COMPUTER	GSOLP	I	MSFC DEVELOPED	Y	Y	Y	N
GENERATE CANDIDATE STELLAR GUIDE STARS (DS)	CAND GSTAR	COMPUTER	GSOLP	O	FORMAT STELLAR GUIDE STAR CATALOG (DS)	Y	Y	Y	N
FORMAT STELLAR GUIDE STAR CATALOG (DS)	SKYMAP DATBSE	COMPUTER	GSOLP	I	MSFC DEVELOPED	Y	Y	Y	N
FORMAT STELLAR GUIDE STAR CATALOG (DS)	CAND GSTAR	COMPUTER	GSOLP	I	GENERATE CANDIDATE STELLAR GUIDE STARS (DS)	Y	Y	Y	N
FORMAT STELLAR GUIDE STAR CATALOG (DS)	GSTAR CAT	COMPUTER	GSOLP	O	GENERATE STELLAR OBJECTIVE LOADS (DS)	Y	Y	Y	N

```
                                                    ACTIVITY INPUT/OUTPUTS                            DATE 03/19/87

                                                                                                      PAGE        34

                                                         SW ASSOC.                                         CYCLES INPUT/OUTPUT DURING
ACTIVITY             INPUT/OUTPUT NAME    I/O FORM      WITH      TYPE       SOURCE/DESTINATION     PREL   BASIC  UPDT  RPLNG
-------------------- -------------------- ----------  ----------  ---------- --------------------   ----   -----  ----  -----
SELECT IPS ROLL      SCIENCE SCHEDULE     COMPUTER    GIMBAL      I          SCHEDULE SCIENCE        Y       Y     Y      N
ANGLES (DS)                                                                  OBSERVATIONS (DS)

SELECT IPS ROLL      COO                  COMPUTER    GIMBAL      I          PI DEVELOPED            Y       Y     Y      N
ANGLES (DS)                                                                  (CELESTIAL TARGETS
                                                                             OBSERVATION REQMTS)

SELECT IPS ROLL      PROCAM               COMPUTER    GIMBAL      I          GENERATE ORBITER        Y       Y     Y      Y
ANGLES (DS)                                                                  POINTING DATA

SELECT IPS ROLL      IPS ROLL ANGLES      COMPUTER    GIMBAL      O          GENERATE STELLAR        Y       Y     Y      N
ANGLES (DS)                                                                  OBJECTIVE LOADS (DS)

GENERATE STELLAR     IPS ROLL ANGLES      COMPUTER    GSOLP       I          SELECT IPS ROLL         Y       Y     Y      N
OBJECTIVE LOADS (DS)                                                         ANGLES (DS)

GENERATE STELLAR     GSTAR CAT            COMPUTER    GSOLP       I          FORMAT STELLAR GUIDE    Y       Y     Y      N
OBJECTIVE LOADS (DS)                                                         STAR CATALOG (DS)

GENERATE STELLAR     OBJ LOAD             COMPUTER    GSOLP       O          MMU LOAD INPUT          Y       Y     Y      N
OBJECTIVE LOADS (DS)                                                         DEVELOPMENT

GENERATE STELLAR     STELLAR OBJ LOAD     COMPUTER    GSOLP       O          USED FOR STELLAR        Y       Y     Y      N
OBJECTIVE LOADS (DS) SUMMARY                                                 OBJECTIVE LOAD
                                                                             VERIFICATION AND
                                                                             GENERAL INFORMATION

GENERATE STELLAR     OBJ LOAD             COMPUTER    GSOLP       O          GENERATE IPS POINTING   Y       Y     Y      N
OBJECTIVE LOADS (DS)                                                         DATA (DS)

GENERATE IPS         PROCAM               COMPUTER    IPOL        I          GENERATE ORBITER        Y       Y     Y      Y
POINTING DATA (DS)                                                           POINTING DATA

..........................................................................................................................
```

ACTIVITY INPUT/OUTPUTS

DATE 03/19/87

ACTIVITY	INPUT/OUTPUT NAME	I/O FORM	SW ASSOC. WITH	TYPE	SOURCE/DESTINATION	CYCLES INPUT/OUTPUT DURING PREL	BASIC	UPDT	RPLNG
GENERATE IPS POINTING DATA (DS)	COO	COMPUTER	IPOL	I	PI DEVELOPED (CELESTIAL TARGETS OBSERVATION REQMTS)	Y	Y	Y	N
GENERATE IPS POINTING DATA (DS)	OBJ LOAD	COMPUTER	IPOL	I	GENERATE STELLAR OBJECTIVE LOADS (DS)	Y	Y	Y	N
GENERATE IPS POINTING DATA (DS)	SCIENCE SCHED'LE	COMPUTER	IPOL	I	SCHEDULE SCIENCE OBSERVATIONS (DS)	Y	Y	Y	Y
GENERATE IPS POINTING DATA (DS)	ID LIST	COMPUTER	IPOL	O	PI EDITS TO ADD SEQUENCE NUMBER (DS)	Y	Y	Y	N
GENERATE IPS POINTING DATA (DS)	IPOL	COMPUTER	IPOL	O	GENERATE PCAP CHARTS	Y	Y	Y	Y
GENERATE IPS POINTING DATA (DS)	IPOL	COMPUTER	IPOL	O	GENERATE JOINT OPERATIONS TARGET FILE (DS)	Y	Y	Y	Y
PI EDITS TO ADD SEQUENCE NUMBER (DS)	ID LIST	COMPUTER	EDT	I	GENERATE IPS POINTING DATA (DS)	Y	Y	Y	N
PI EDITS TO ADD SEQUENCE NUMBER (DS)	ID/SEQ LIST	COMPUTER	EDT	O	GENERATE JOINT OPERTIONS TARGET FILE (DS)	Y	Y	Y	N
GENERATE JOINT OPERATIONS TARGET FILE (DS)	COO	COMPUTER	JOTF	I	PI DEVELOPED (CELESTIAL TARGETS OBSERVATION REQMTS)	Y	Y	Y	N
GENERATE JOINT OPERATIONS TARGET FILE (DS)	IPOL	COMPUTER	JOTF	I	GENERATE IPS POINTING DATA (DS)	Y	Y	Y	Y

ACTIVITY	INPUT/OUTPUT NAME	I/O FORM	SW ASSOC. WITH	TYPE	SOURCE/DESTINATION	CYCLES INPUT/OUTPUT DURING PREL	BASIC	UPDT	RPLNG
GENERATE JOINT OPERATIONS TARGET FILE (DS)	SCIENCE SCHED'LE	COMPUTER	JOTF	I	SCHEDULE SCIENCE OBSERVATIONS (DS)	Y	Y	Y	Y
GENERATE JOINT OPERATIONS TARGET FILE (DS)	ID/SEQ LIST	COMPUTER	JOTF	I	PI EDITS TO ADD SEQUENCE NUMBER (DS)	Y	Y	Y	N
GENERATE JOINT OPERATIONS TARGET FILE (DS)	JOTF	COMPUTER	JOTF	O	MMU LOAD INPUT DEVELOPMENT	Y	Y	Y	Y
GENERATE JOINT OPERATIONS TARGET FILE (DS)	JOTF VERIFICATION REPORT	COMPUTER	JOTF	O	MANUAL VERIFICATION OF JOTF FILE	Y	Y	Y	Y
CREATE MISSION TIMELINE MODELS	STS CAPABILITIES DOCUMENTATION	MANUAL	VME	I	STS CAPABILITIES DEFINITION (JSC)	Y	Y	Y	N
CREATE MISSION TIMELINE MODELS	MISSION CONFIGURATION	MANUAL	VME	I	PAYLOAD COMPLEMENT DEFINITION (JSC)	Y	Y	Y	N
CREATE MISSION TIMELINE MODELS	ERD'S	MANUAL	VME	I	PI'S EXPERIMENT REQMTS INPUTS	Y	N	N	N
CREATE MISSION TIMELINE MODELS	O&IA	MANUAL	VME	I	PAYLOAD DATA COLLECTION	N	Y	Y	N
CREATE MISSION TIMELINE MODELS	SPAH & SL SYSTEM DOCUMENTATION	MANUAL	VME	I	SPACELAB CONFIGURATION DEFINITION	Y	Y	Y	N
CREATE MISSION TIMELINE MODELS	BASIC CREW CYCLE (JSC)	MANUAL	VME	I	CREW SYSTEMS CONSTRAINTS (JSC)	Y	Y	Y	N

			SW ASSOC.			CYCLES INPUT/OUTPUT DURING			
ACTIVITY	INPUT/OUTPUT NAME	I/O FORM	WITH	TYPE	SOURCE/DESTINATION	PREL	BASIC	UPDT	RPLNG
CREATE MISSION TIMELINE MODELS	ESS MODEL	COMPUTER	VME	O	GENERATE PCAP CHARTS	Y	Y	Y	N
CREATE MISSION TIMELINE MODELS	ESS MODEL	COMPUTER	VME	O	CREATE ESS TARGET FILE	Y	Y	Y	N
CREATE MISSION TIMELINE MODELS	ESS MODEL	COMPUTER	VME	O	DATA FLOW	Y	Y	Y	N
CREATE MISSION TIMELINE MODELS	ESS MODEL	COMPUTER	VME	O	GENERATE MISSION TIMELINE	Y	Y	Y	N
CREATE MISSION TIMELINE MODELS	ESS MODELS PRINTOUT	COMPUTER	VME	O	GENERATE CREW H/O CYCLE	Y	Y	Y	N
GENERATE CREW H/O CYCLE	BASIC CREW CYCLE (JSC)	MANUAL	NONE	I	CREW SYSTEMS CONSTRAINTS (JSC)	Y	Y	Y	Y
GENERATE CREW H/O CYCLE	ESS MODELS PRINTOUT	MANUAL	NONE	I	CREATE MISSION TIMELINE MODELS	Y	Y	Y	Y
GENERATE CREW H/O CYCLE	CREW H/O CYCLE	MANUAL	NONE	O	CREATE RESERVE PERIOD FILE (DS)	Y	Y	Y	Y
GENERATE CREW H/O CYCLE	CREW H/O CYCLE	MANUAL	NONE	O	GENERATE MISSION TIMELINE	Y	Y	Y	Y
GENERATE CREW H/O CYCLE	CREW H/O CYCLE	MANUAL	NONE	O	DEVELOP GROSS MISSION TIMELINE	Y	Y	Y	Y
CREATE ESS TARGET FILE	ESS MODEL	COMPUTER	TAE	I	CREATE MISSION TIMELINE MODELS	Y	Y	Y	Y

ACTIVITY INPUT/OUTPUTS

ACTIVITY	INPUT/OUTPUT NAME	I/O FORM	SW ASSOC. WITH	TYPE	SOURCE/DESTINATION	CYCLES INPUT/OUTPUT DURING PREL	BASIC	UPDT	RPLNG
CREATE ESS TARGET FILE	TDRS AC/LOS	COMPUTER	TAE	I	GENERATE TDRS COVERAGE	Y	Y	Y	Y
CREATE ESS TARGET FILE	ATT TL	COMPUTER	TAE	I	EDIT TO INCORPORATE STS OR OTHER REQMTS (DS)	Y	Y	Y	Y
CREATE ESS TARGET FILE	ATT TL	COMPUTER	TAE	I	EDIT CURRENT ATTITUDE T/L TO INCORPORATE STS OR OTHER REQMTS	Y	Y	Y	Y
CREATE ESS TARGET FILE	SCIENCE SCHED'LE	COMPUTER	TAE	I	SCHEDULE SCIENCE OBSERVATIONS (DS)	Y	Y	Y	Y
CREATE ESS TARGET FILE	MSN TARGETS	COMPUTER	TAE	I	MERGE ALL EXPERIMENT TARGET FILES	Y	Y	Y	Y
CREATE ESS TARGET FILE	SPECIAL TARGETS	MANUAL	TAE	I	PI'S, MSN T/L ENGR'S, MGMT DIRECTION	Y	Y	Y	Y
CREATE ESS TARGET FILE	ESS TARGET PRINTOUTS	COMPUTER	TAE	O	CREATE MASTER INPUT FILES	N	Y	N	N
CREATE ESS TARGET FILE	ESS TARGET	COMPUTER	TAE	O	CREATE MASTER TIMELINE	Y	Y	Y	Y
CREATE ESS TARGET FILE	TARGET ANALYSIS PRINTOUT	COMPUTER	TAE	O	MISSION T/L ENG'S	Y	Y	Y	Y
CREATE ESS TARGET FILE	ESS TARGET	COMPUTER	TAE	O	GENERATE POCC CHECKLIST AND COMMAND TIMELINE	Y	Y	Y	Y

ACTIVITY	INPUT/OUTPUT NAME	I/O FORM	SW ASSOC. WITH	TYPE	SOURCE/DESTINATION	CYCLES INPUT/OUTPUT DURING			
						PREL	BASIC	UPDT	RPLNG
CREATE ESS TARGET FILE	ESS TARGET	COMPUTER	TAE	O	GENERATE MISSION TIMELINE	Y	Y	Y	Y
GENERATE MISSION TIMELINE	ESS MODEL	COMPUTER	ESP	I	CREATE MISSION TIMELINE MODELS	Y	Y	Y	Y
GENERATE MISSION TIMELINE	ESS TARGET	COMPUTER	ESP	I	CREATE ESS TARGET FILE	Y	Y	Y	Y
GENERATE MISSION TIMELINE	PAO REQMTS	MANUAL	ESP	I	PAO REQUIREMENTS INPUT	N	Y	Y	Y
GENERATE MISSION TIMELINE	MGMT AGREEMENT ON GROSS MSN T/L	MANUAL	ESP	I	DEVELOP GROSS MISSION TIMELINE	Y	Y	Y	Y
GENERATE MISSION TIMELINE	CREW H/O CYCLE	MANUAL	ESP	I	GENERATE CREW H/O CYCLE	Y	Y	Y	Y
GENERATE MISSION TIMELINE	CREW ACT	COMPUTER	ESP	O	GENERATE PTS CHARTS	Y	Y	Y	Y
GENERATE MISSION TIMELINE	EXP T/L	COMPUTER	ESP	O	CREATE MASTER TIMELINE	N	Y	Y	Y
GENERATE MISSION TIMELINE	MVR TL	COMPUTER	ESP	O	GENERATE ATTITUDE TIMELINE	Y	Y	Y	Y
GENERATE MISSION TIMELINE	EXP T/L	COMPUTER	ESP	O	GENERATE POCC CHECKLIST AND COMMAND TIMELINE	N	Y	Y	Y
GENERATE MISSION TIMELINE	EXP	COMPUTER	ESP	O	GENERATE PTS CHARTS	Y	Y	Y	Y

ACTIVITY	INPUT/OUTPUT NAME	I/O FORM	SW ASSOC. WITH	TYPE	SOURCE/DESTINATION	CYCLES INPUT/OUTPUT DURING PREL	BASIC	UPDT	RPLNG
GENERATE MISSION TIMELINE	INHBT	COMPUTER	ESP	O	GENERATE PTS CHARTS	Y	Y	Y	Y
GENERATE MISSION TIMELINE	JSC CAP	COMPUTER	ESP	O	TO JSC FOR REVIEW	N	Y	Y	Y
GENERATE MISSION TIMELINE	MSN T/L TABLES, PRINTOUTS	COMPUTER	ESP	O	PI'S, ENGR'S, MGMT FOR REVIEW	Y	Y	Y	Y
GENERATE MISSION TIMELINE	EXP T/L	COMPUTER	ESP	O	GENERATE MISSION DATA REQUIREMENTS PROFILE	N	Y	Y	Y
GENERATE MISSION TIMELINE	EXP T/L	COMPUTER	ESP	O	GENERATE PCAP CHARTS	N	Y	Y	Y
GENERATE MISSION TIMELINE	ATTITUDE UPDATES	MANUAL	ESP	O	EDIT TO INCORPORATE STS OR OTHER REQMTS (D5)	Y	Y	Y	Y
GENERATE MISSION TIMELINE	ATTITUDE UPDATES	MANUAL	ESP	O	EDIT CURRENT ATTITUDE T/L TO INCORPORATE STS OR OTHER REQMTS	Y	Y	Y	Y
FINALIZE MISSION TIMELINE	ESS TARGET	COMPUTER	ESP	I	CREATE ESS TARGET FILE	N	Y	Y	Y
FINALIZE MISSION TIMELINE	ESS MODEL	COMPUTER	ESP	I	CREATE MISSION TIMELINE MODELS	N	Y	Y	Y
FINALIZE MISSION TIMELINE	REVIEW CYCLE UPDATES	MANUAL	ESP	I	DIVISION MANAGMENT REWIEW	Y	Y	Y	Y
FINALIZE MISSION TIMELINE	MGMT AGREEMENT ON GROSS MSN T/L	MANUAL	ESP	I	DEVELOP GROSS MISSION TIMELINE	Y	Y	Y	Y

ACTIVITY	INPUT/OUTPUT NAME	I/O FORM	SW ASSOC. WITH	TYPE	SOURCE/DESTINATION	CYCLES INPUT/OUTPUT DURING PREL	BASIC	UPDT	RPLNG
FINALIZE MISSION TIMELINE	REVIEW CYCLE UPDATES	MANUAL	ESP	I	JSC REVIEW	N	Y	Y	Y
FINALIZE MISSION TIMELINE	REVIEW CYCLE UPDATES	MANUAL	ESP	I	ATTITUDE/TDRS ITERATION	Y	Y	Y	Y
FINALIZE MISSION TIMELINE	CREW H/O CYCLE	MANUAL	ESP	I	GENERATE CREW H/O CYCLE	Y	Y	Y	Y
FINALIZE MISSION TIMELINE	PAO REQMTS	MANUAL	ESP	I	PAO REQUIREMENTS INPUT	N	Y	Y	Y
FINALIZE MISSION TIMELINE	REVIEW CYCLE UPDATES	MANUAL	ESP	I	STL/MTL REVIEW UPDATES	N	Y	Y	Y
FINALIZE MISSION TIMELINE	EXP T/L PRINTOUTS	COMPUTER	ESP	O	CREATE MASTER INPUT FILES	N	Y	N	N
FINALIZE MISSION TIMELINE	MVR TL	COMPUTER	ESP	O	GENERATE ATTITUDE TIMELINE	Y	Y	Y	Y
FINALIZE MISSION TIMELINE	EXP T/L	COMPUTER	ESP	O	GENERATE PCAP CHARTS	N	Y	Y	Y
FINALIZE MISSION TIMELINE	EXP T/L	COMPUTER	ESP	O	VERIFICATION OF STL'S/MLT'S	N	Y	Y	Y
FINALIZE MISSION TIMELINE	EXP T/L	COMPUTER	ESP	O	DATA FLOW ANALYSIS FOR VERIFICATION	N	Y	Y	Y
FINALIZE MISSION TIMELINE	MSN T/L TABLES, PRINTOUTS	COMPUTER	ESP	O	PI'S, ENGR'S, MGMT FOR APPROVAL	Y	Y	Y	Y

ACTIVITY	INPUT/OUTPUT NAME	I/O FORM	SW ASSOC. WITH	TYPE	SOURCE/DESTINATION	CYCLES INPUT/OUTPUT DURING PREL	BASIC	UPDT	RPLNG
FINALIZE MISSION TIMELINE	JSC CAP	COMPUTER	ESP	O	TO JSC FOR INCORPORATION INTO THE CAP	N	Y	Y	Y
FINALIZE MISSION TIMELINE	CREW ACT	COMPUTER	ESP	O	GENERATE PTS CHARTS	N	Y	Y	Y
FINALIZE MISSION TIMELINE	EXP	COMPUTER	ESP	O	GENERATE PTS CHARTS	N	Y	Y	Y
FINALIZE MISSION TIMELINE	INHBT	COMPUTER	ESP	O	GENERATE PTS CHARTS	N	Y	Y	Y
FINALIZE MISSION TIMELINE	ATTITUDE UPDATES	MANUAL	ESP	O	EDIT TO INCORPORATE STS OR OTHER REQMTS (DS)	Y	Y	Y	Y
FINALIZE MISSION TIMELINE	ATTITUDE UPDATES	MANUAL	ESP	O	EDIT CURRENT ATTITUDE T/L TO INCORPORATE STS OR OTHER REQMTS	Y	Y	Y	Y
GENERATE PCAP CHARTS	PROC.	COMPUTER	PCAP	I	DATABASE	N	Y	Y	Y
GENERATE PCAP CHARTS	ESS MODEL	COMPUTER	PCAP	I	CREATE MISSION TIMELINE MODELS	N	Y	Y	Y
GENERATE PCAP CHARTS	TDRS AC/LOS	COMPUTER	PCAP	I	GENERATE TDRS COVERAGE	N	Y	Y	Y
GENERATE PCAP CHARTS	DATA FLOW SCHED	COMPUTER	PCAP	I	GENERATE DATA FLOW REPORTS	N	Y	Y	Y
GENERATE PCAP CHARTS	IPOL	COMPUTER	PCAP	I	GENERATE IPS POINTING DATA (DS)	N	Y	Y	Y

ACTIVITY	INPUT/OUTPUT NAME	I/O FORM	SW ASSOC. WITH	TYPE	SOURCE/DESTINATION	CYCLES INPUT/OUTPUT DURING PREL	BASIC	UPDT	RPLNG
GENERATE PCAP CHARTS	MSN TARGETS	COMPUTER	PCAP	I	MERGE ALL EXPERIMENT TARGET FILES	N	Y	Y	Y
GENERATE PCAP CHARTS	EXP T/L	COMPUTER	PCAP	I	GENERATE MISSION TIMELINE	N	Y	Y	Y
GENERATE PCAP CHARTS	NOTES	COMPUTER	PCAP	I	DATABASE	N	Y	Y	Y
GENERATE PCAP CHARTS	ATT TL	COMPUTER	PCAP	I	EDIT CURRENT ATTITUDE T/L TO INCORPORATE STS OR OTHER REQMTS	N	Y	Y	Y
GENERATE PCAP CHARTS	ATT TL	COMPUTER	PCAP	I	EDIT TO INCORPORATE STS OR OTHER REQMTS	N	Y	Y	Y
GENERATE PCAP CHARTS	SPECIAL TIMELINE NOTES	MANUAL	PCAP	I	MISSION T/L ENGINEERS INPUTS	N	Y	Y	Y
GENERATE PCAP CHARTS	CREW PROCEDURES DOCUMENT	MANUAL	PCAP	I	DEVELOP EXPERIMENT CREW PROCEDURES	N	Y	Y	Y
GENERATE PCAP CHARTS	SPECIAL CREW NOTES	MANUAL	PCAP	I	CREW REQMTS FOR PCAP	N	Y	Y	Y
GENERATE PCAP CHARTS	SHIFT TIMES	MANUAL	PCAP	I	MISSION T/L ENGINEERS INPUTS	N	Y	Y	Y
GENERATE PCAP CHARTS	PCAP CHARTS	COMPUTER	PCAP	O	BUILD PCAP DOCUMENT	N	Y	Y	Y
GENERATE PTS CHARTS	DATA FLOW SCHED	COMPUTER	PTS	I	GENERATE DATA FLOW REPORTS	Y	Y	Y	Y
GENERATE PTS CHARTS	PROCAM	COMPUTER	PTS	I	GENERATE ORBITER POINTING DATA	Y	Y	Y	Y

ACTIVITY	INPUT/OUTPUT NAME	I/O FORM	SW ASSOC. WITH	TYPE	SOURCE/DESTINATION	CYCLES INPUT/OUTPUT DURING PREL	BASIC	UPDT	RPLNG
GENERATE PTS CHARTS	ATT TL	COMPUTER	PTS	I	EDIT TO INCORPORATE STS OR OTHER REQMTS (D5)	Y	Y	Y	Y
GENERATE PTS CHARTS	CREW ACT	COMPUTER	PTS	I	GENERATE MISSION TIMELINE	Y	Y	Y	Y
GENERATE PTS CHARTS	GND TRK	COMPUTER	PTS	I	GENERATE REQUIRED EPHEMERIS DATA FOR OUTPUT	Y	Y	Y	Y
GENERATE PTS CHARTS	MSN TARGETS	COMPUTER	PTS	I	MERGE ALL EXPERIMENT TARGET FILES	Y	Y	Y	Y
GENERATE PTS CHARTS	EXP	COMPUTER	PTS	I	GENERATE MISSION TIMELINE	Y	Y	Y	Y
GENERATE PTS CHARTS	ATT TL	COMPUTER	PTS	I	EDIT CURRENT ATTITUDE T/L TO INCORPORATE STS OR OTHER REQMTS	Y	Y	Y	Y
GENERATE PTS CHARTS	INHBT	COMPUTER	PTS	I	MISSION TIMELINE GENERATION	Y	Y	Y	Y
GENERATE PTS CHARTS	TDRS AC/LOS	COMPUTER	PTS	I	GENERATE TDRS COVERAGE	Y	Y	Y	Y
GENERATE PTS CHARTS	SOPG TIMES	MANUAL	PTS	I	MISSION T/L ENGINEER INPUT	Y	Y	Y	Y
GENERATE PTS CHARTS	PTS CHARTS	COMPUTER	PTS	O	FLIGHT DEFINITION DOCUMENT DEVELOPMENT	Y	Y	Y	Y
GENERATE PTS CHARTS	PTS CHARTS	COMPUTER	PTS	O	BUILD PCAP DOCUMENT	Y	Y	Y	Y

ACTIVITY	INPUT/OUTPUT NAME	I/O FORM	SW ASSOC. WITH	TYPE	SOURCE/DESTINATION	CYCLES INPUT/OUTPUT DURING PREL	BASIC	UPDT	RPLNG
BUILD PCAP DOCUMENT	PTS CHARTS	MANUAL	NONE	I	GENERATE PTS CHARTS	N	Y	Y	Y
BUILD PCAP DOCUMENT	PCAP CHARTS	MANUAL	NONE	I	GENERATE PCAP CHARTS	N	Y	Y	Y
BUILD PCAP DOCUMENT	PCAP DOCUMENT	MANUAL	NONE	O	PAYLOAD FLIGHT DATA FILE	N	Y	Y	Y
FLIGHT DEFINITION DOCUMENT DEVELOPMENT	DATA FLOW ANALYSIS FDD INPUTS	MANUAL	NONE	I	DATA FLOW ANALYSIS TASKS	Y	Y	Y	N
FLIGHT DEFINITION DOCUMENT DEVELOPMENT	ORBIT ANALYSIS FDD INPUTS	MANUAL	NONE	I	ORBIT ANALYSIS TASKS	Y	Y	Y	N
FLIGHT DEFINITION DOCUMENT DEVELOPMENT	MISSION T/L ANALYSIS FDD INPUTS	MANUAL	NONE	I	MISSION T/L ANALYSIS TASKS	Y	Y	Y	N
FLIGHT DEFINITION DOCUMENT DEVELOPMENT	FLIGHT DEFINITION DOCUMENT	MANUAL	NONE	O	PUBLICATION	Y	Y	Y	N
FLIGHT PLANNING ANNEX INPUT DEVELOPMENT	COOLING LOAD RQMTS	MANUAL	NONE	I	THERMAL ANALYSIS (MSFC)	N	Y	N	N
FLIGHT PLANNING ANNEX INPUT DEVELOPMENT	HDRR DUMP TIMES	MANUAL	NONE	I	DATA FLOW ANALYSIS TASKS	N	Y	N	N
FLIGHT PLANNING ANNEX INPUT DEVELOPMENT	MISSION T/L ANALYSIS FPA INPUTS	MANUAL	NONE	I	MISSION T/L ANALYSIS TASKS	N	Y	N	N
FLIGHT PLANNING ANNEX INPUT DEVELOPMENT	ORBIT ANALYSIS FPA INPUTS	MANUAL	NONE	I	ORBIT ANALYSIS TASKS	N	Y	N	N

ACTIVITY INPUT/OUTPUTS

ACTIVITY	INPUT/OUTPUT NAME	I/O FORM	SW ASSOC. WITH	TYPE	SOURCE/DESTINATION	CYCLES INPUT/OUTPUT DURING PREL	BASIC	UPDT	RPLNG
FLIGHT PLANNING ANNEX INPUT DEVELOPMENT	FPA INPUTS	MANUAL	NONE	O	FLIGHT PLANNING ANNEX INPUTS TO JSC	N	Y	N	N
DEVELOP STOWAGE BOOK	OTHER PI INPUTS	MANUAL	NONE	I	PI REQMTS INPUT	Y	Y	Y	N
DEVELOP STOWAGE BOOK	ERD'S, FO'S AND/OR O&IA DOC	MANUAL	NONE	I	PAYLOAD DATA COLLECTION	Y	Y	Y	N
DEVELOP STOWAGE BOOK	MSN T/L TABLES, PRINTOUTS	MANUAL	NONE	I	GENERATE MISSION TIMELINE	Y	Y	Y	N
DEVELOP STOWAGE BOOK	STOWAGE BOOK	MANUAL	NONE	O	BUILD PFDF DOCUMENTS	Y	Y	Y	N
DEVELOP TV, PHOTO PROCEDURES	TV, PHOTO SYSTEM CAPABILITIES	MANUAL	NONE	I	SPAN, ICD'S, ETC.	Y	Y	Y	N
DEVELOP TV, PHOTO PROCEDURES	MSN T/L TABLES, PRINTOUTS	MANUAL	NONE	I	GENERATE MISSION TIMELINE	Y	Y	Y	N
DEVELOP TV, PHOTO PROCEDURES	ERD'S, FO'S AND/OR O&IA DOC	MANUAL	NONE	I	PAYLOAD DATA COLLECTION	Y	Y	Y	N
DEVELOP TV, PHOTO PROCEDURES	OTHER PI INPUTS	MANUAL	NONE	I	PI REQMTS INPUT	Y	Y	Y	N
DEVELOP TV, PHOTO PROCEDURES	TV, PHOTO OPS HANDBOOK	MANUAL	NONE	O	BUILD PFDF DOCUMENTS	Y	Y	Y	N
DEVELOP EXPERIMENT CREW PROCEDURES	MSN T/L TABLES, PRINTOUTS	MANUAL	NONE	I	GENERATE MISSION TIMELINE	Y	Y	Y	N
DEVELOP EXPERIMENT CREW PROCEDURES	OTHER PI INPUTS	MANUAL	NONE	I	PI REQMTS INPUT	Y	Y	Y	N

ACTIVITY INPUT/OUTPUTS

ACTIVITY	INPUT/OUTPUT NAME	I/O FORM	SW ASSOC. WITH	TYPE	SOURCE/DESTINATION	CYCLES INPUT/OUTPUT DURING PREL	BASIC	UPDT	RPLNG
DEVELOP EXPERIMENT CREW PROCEDURES	ERD'S, FO'S AND/OR O&IA DOC	MANUAL	NONE	I	PAYLOAD DATA COLLECTION	Y	N	N	N
DEVELOP EXPERIMENT CREW PROCEDURES	EXP CREW PROCEDURES DOC	MANUAL	NONE	O	BUILD PFDF DOCUMENTS	Y	Y	Y	N
DEVELOP PAYLOAD SYSTEMS HANDBOOK	MSN T/L TABLES, PRINTOUTS	MANUAL	NONE	I	GENERATE MISSION TIMELINE	Y	Y	Y	N
DEVELOP PAYLOAD SYSTEMS HANDBOOK	ERD'S, FO'S AND/OR O&IA DOC	MANUAL	NONE	I	PAYLOAD DATA COLLECTION	Y	Y	Y	N
DEVELOP PAYLOAD SYSTEMS HANDBOOK	OTHER PI INPUTS	MANUAL	NONE	I	PI REQMTS INPUT	Y	Y	Y	N
DEVELOP PAYLOAD SYSTEMS HANDBOOK	MPE OPS REQMTS	MANUAL	NONE	I	SPAH, ICD'S, ECT.	Y	Y	Y	N
DEVELOP PAYLOAD SYSTEMS HANDBOOK	SL/PL INTERFACE DEFINITION	MANUAL	NONE	I	SPAH, ICD'S, ETC.	Y	Y	Y	N
DEVELOP PAYLOAD SYSTEMS HANDBOOK	PAYLOAD SYSTEMS HANDBOOK	MANUAL	NONE	O	BUILD PFDF DOCUMENT	Y	Y	Y	N
DEVELOP CDMS DICTIONARY	MSN T/L TABLES, PRINTOUTS	MANUAL	NONE	I	GENERATE MISSION TIMELINE	Y	Y	Y	N
DEVELOP CDMS DICTIONARY	OTHER PI INPUTS	MANUAL	NONE	I	PI REQMTS INPUT	Y	Y	Y	N
DEVELOP CDMS DICTIONARY	ERD'S, FO'S AND/OR O&IA DOC	MANUAL	NONE	I	PAYLOAD DATA COLLECTION	Y	Y	Y	N

ACTIVITY INPUT/OUTPUTS

ACTIVITY	INPUT/OUTPUT NAME	I/O FORM	SW ASSOC. WITH	TYPE	SOURCE/DESTINATION	CYCLES INPUT/OUTPUT DURING			
						PREL	BASIC	UPDT	RPLNG
DEVELOP CDMS DICTIONARY	CDMS SYSTEM DEFINITION	MANUAL	NONE	I	DESIGN DOCUMENTATION	Y	Y	Y	N
DEVELOP CDMS DICTIONARY	CDMS DICTIONARY	MANUAL	NONE	O	BUILD PFDF DOCUMENTS	N	N	Y	N
BUILD PFDF DOCUMENTS	CDMS DICTIONARY	MANUAL	NONE	I	DEVELOP CDMS DICTIONARY	Y	Y	Y	N
BUILD PFDF DOCUMENTS	TV, PHOTO OPS HANDBOOK	MANUAL	NONE	I	DEVELOP TV, PHOTO PROCEDURES	Y	Y	Y	N
BUILD PFDF DOCUMENTS	STOWAGE BOOK	MANUAL	NONE	I	DEVELOP STOWAGE BOOK	Y	Y	Y	N
BUILD PFDF DOCUMENTS	EXP CREW PROCEDURES DOC	MANUAL	NONE	I	DEVELOP EXPERIMENT CREW PROCEDURES	Y	Y	Y	N
BUILD PFDF DOCUMENTS	PAYLOAD SYSTEMS HANDBOOK	MANUAL	NONE	I	DEVELOP PAYLOAD SYSTEMS HANDBOOK	Y	Y	Y	N
BUILD PFDF DOCUMENTS	PFDF DOCUMENTS	MANUAL	NONE	O	CREW,MSN SUPPORT PERSONNEL	Y	Y	Y	N
CREATE DATA FLOW MODELS	PI INTERFACE	MANUAL	EDT	I	PI INTERVIEWS, DISCUSSIONS	Y	Y	N	N
CREATE DATA FLOW MODELS	ERD'S, FD'S AND/OR OBIA DOC	MANUAL	EDT	I	PAYLOAD DATA COLLECTION	Y	Y	Y	N
CREATE DATA FLOW MODELS	DATA FLOW MODELS	COMPUTER	EDT	O	GENERATE MISSION DATA REQUIREMENTS PROFILE	Y	Y	Y	N

C-4

```
                                                SW ASSOC.                                           CYCLES INPUT/OUTPUT DURING
ACTIVITY              INPUT/OUTPUT NAME    I/O FORM    WITH       TYPE       SOURCE/DESTINATION     PREL  BASIC  UPDT  RPLNG
....................  ...................  .........  .........  .........  ....................  ....  .....  ....  .....
GENERATE MISSION      EXP T/L              COMPUTER   DF/MDRPG   I          GENERATE MISSION       Y     Y      Y     Y
DATA REQUIREMENTS                                                           TIMELINE
PROFILE

GENERATE MISSION      HRM FORMATS DEFN     COMPUTER   DF/MDRPG   I          HRM FORMATS            Y     Y      Y     N
DATA REQUIREMENTS                                                           DEFINITIONS
PROFILE

GENERATE MISSION      POCC CONFIG DEFN     COMPUTER   DF/MDRPG   I          POCC CONFIGURATION     Y     Y      Y     N
DATA REQUIREMENTS                                                           DEFINITION
PROFILE

GENERATE MISSION      DATA FLOW INPUT      COMPUTER   DF/MDRPG   I          MISSION SUPPORT        Y     Y      Y     N
DATA REQUIREMENTS     VARIABLES                                             ACTIVITIES INPUT
PROFILE                                                                     VARIABLES

GENERATE MISSION      DATA FLOW MODELS     COMPUTER   DF/MDRPG   I          CREATE DATA FLOW       Y     Y      Y     N
DATA REQUIREMENTS                                                           MODELS
PROFILE

GENERATE MISSION      DATA FLOW REQMTS     COMPUTER   DF/MDRPG   I          DATA FLOW              Y     Y      Y     N
DATA REQUIREMENTS                                                           REQUIREMENTS INPUTS
PROFILE

GENERATE MISSION      PROFILE              COMPUTER   DF/MDRPG   O          UPDATE OR ENHANCE      Y     Y      Y     Y
DATA REQUIREMENTS                                                           EXISTING SCHEDULES
PROFILE

GENERATE MISSION      PROFILE              COMPUTER   DF/MDRPG   O          GENERATE POCC          Y     Y      Y     Y
DATA REQUIREMENTS                                                           POSSIBLE
PROFILE                                                                     CONFIGURATIONS
...........................................................................................................................
```

ACTIVITY	INPUT/OUTPUT NAME	I/O FORM	SW ASSOC. WITH	TYPE	SOURCE/DESTINATION	CYCLES INPUT/OUTPUT DURING PREL	BASIC	UPDT	RPLNG
GENERATE MISSION DATA REQUIREMENTS PROFILE	PROFILE	COMPUTER	DF/MDRPG	O	SCHEDULE HRM FORMATS AND DOWNLINK	Y	Y	Y	Y
GENERATE MISSION DATA REQUIREMENTS PROFILE	PROFILE	COMPUTER	DF/MDRPG	O	GENERATE DATA FLOW REPORTS	Y	Y	Y	Y
GENERATE MISSION DATA REQUIREMENTS PROFILE	PROFILE	COMPUTER	DF/MDRPG	O	SCHEDULE RECORDER PLAYBACKS	Y	Y	Y	Y
GENERATE MISSION DATA REQUIREMENTS PROFILE	MDRPG ERROR	COMPUTER	DF/MDRPG	O	DATA FLOW ANALYSIS ENGINEERS FOR EVALUATION	Y	Y	Y	Y
GENERATE MISSION DATA REQUIREMENTS PROFILE	PROFILE	COMPUTER	DF/MDRPG	O	GENERATE HRM POSSIBLE FORMATS	Y	Y	Y	Y
GENERATE MISSION DATA REQUIREMENTS PROFILE	PROFILE	COMPUTER	DF/MDRPG	O	GENERATE MISSION WINDOWS	Y	Y	Y	Y
GENERATE MISSION WINDOWS	DATA FLOW INPUT VARIABLES	COMPUTER	DF/MAG	I	MISSION SUPPORT ACTIVITIES INPUT VARIABLES	Y	Y	Y	Y
GENERATE MISSION WINDOWS	HRM FORMATS DEFN	COMPUTER	DF/MAG	I	HRM FORMATS DEFINITION	Y	Y	Y	Y
GENERATE MISSION WINDOWS	COMM AC/LOS	COMPUTER	DF/MAG	I	PROCESS TDRS DATA FOR ENHANCEMENT	Y	Y	Y	Y

ACTIVITY INPUT/OUTPUTS

ACTIVITY	INPUT/OUTPUT NAME	I/O FORM	SW ASSOC. WITH	TYPE	SOURCE/DESTINATION	CYCLES INPUT/OUTPUT DURING PREL	BASIC	UPDT	RPLNG
GENERATE MISSION WINDOWS	PROFILE	COMPUTER	DF/MWG	I	GENERATE MISSION DATA REQUIREMENTS PROFILE	Y	Y	Y	Y
GENERATE MISSION WINDOWS	DFA SCHEULAR CMNDS	COMPUTER	DF/MWG	I	MANUAL FEEDBACK TO UPDATE SCHEDULES BASED ON EVALUATION OF ERROR FILES	Y	Y	Y	Y
GENERATE MISSION WINDOWS	MISSION WINDOWS	COMPUTER	DF/MWG	O	SCHEDULE ONBOARD RECORDER OPERATIONS	Y	Y	Y	Y
GENERATE MISSION WINDOWS	MISSION WINDOWS	COMPUTER	DF/MWG	O	VERIFY DATA FLOW SCHEDULES	Y	Y	Y	Y
GENERATE MISSION WINDOWS	MWG ERROR	COMPUTER	DF/MWG	O	DATA FLOW ANALYSIS ENGINEERS FOR EVALUATION	Y		Y	Y
SCHEDULE ONBOARD RECORDER OPERATIONS	MISSION WINDOWS	COMPUTER	DF/ORS	I	GENERATE MISSION WINDOWS	Y	Y	Y	Y
SCHEDULE ONBOARD RECORDER OPERATIONS	DFA SCHEDULAR CMNDS	COMPUTER	DF/ORS	I	MANUAL FEEDBACK TO UPDATE SCHEDULES BASED ON EVALUATION OF ERROR FILES	Y	Y	Y	Y
SCHEDULE ONBOARD RECORDER OPERATIONS	DATA FLOW INPUT VARIABLES	COMPUTER	DF/ORS	I	MISSION SUPPORT ACTIVITIES INPUT VARIABLES	Y	Y	Y	Y
SCHEDULE ONBOARD RECORDER OPERATIONS	MASTER FILE	COMPUTER	DF/ORS	O	SCHEDULE NRM FORMATS AND DOWNLINK	Y	Y	Y	Y

```
                                        ACTIVITY INPUT/OUTPUTS                               DATE 03/19/87

                                                                                             PAGE        52

                                                         SW ASSOC.                           CYCLES INPUT/OUTPUT DURING
ACTIVITY             INPUT/OUTPUT NAME   I/O FORM      WITH       TYPE      SOURCE/DESTINATION   PREL  BASIC  UPDT  RPLNG
-------------------- ------------------- ----------  ---------- ---------- -------------------- ----  -----  ----  -----
SCHEDULE ONBOARD     ORS ERROR           COMPUTER      DF/ORS      O        DATA FLOW ANALYSIS    Y      Y      Y     Y
RECORDER OPERATIONS                                                         ENGINEERS FOR
                                                                            EVALUATION

SCHEDULE ONBOARD     MASTER FILE         COMPUTER      DF/ORS      O        GENERATE HRM POSSIBLE Y      Y      Y     Y
RECORDER OPERATIONS                                                         FORMATS

GENERATE HRM         DFA SCHEDULAR CMNDS COMPUTER      DF/HPFG     I        MANUAL FEEDBACK TO    Y      Y      Y     Y
POSSIBLE FORMATS                                                            UPDATE SCHEDULES
                                                                            BASED ON EVALUATION
                                                                            OF ERROR FILES

GENERATE HRM         PROFILE             COMPUTER      DF/HPFG     I        GENERATE MISSION DATA Y      Y      Y     Y
POSSIBLE FORMATS                                                            REQUIREMENTS PROFILE

GENERATE HRM         HRM FORMATS DEFN    COMPUTER      DF/HPFG     I        HRM FORMATS           Y      Y      Y     Y
POSSIBLE FORMATS                                                            DEFINITION

GENERATE HRM         DATA FLOW INPUT     COMPUTER      DF/HPFG     I        MISSION SUPPORT       Y      Y      Y     Y
POSSIBLE FORMATS     VARIABLES                                              ACTIVITIES INPUT
                                                                            VARIABLES

GENERATE HRM         MASTER FILE         COMPUTER      DF/HPFG     I        SCHEDULE ONBOARD      Y      Y      Y     Y
POSSIBLE FORMATS                                                            RECORDER OPERATIONS

GENERATE HRM         HRM POSSIBLE FORMATS COMPUTER     DF/HPFG     O        SCHEDULE HRM FORMATS  Y      Y      Y     Y
POSSIBLE FORMATS                                                            AND DOWNLINK

GENERATE HRM         HRM POSSIBLE FORMATS COMPUTER     DF/HPFG     O        GENERATE DATA FLOW    Y      Y      Y     Y
POSSIBLE FORMATS                                                            REPORTS

GENERATE HRM         HRM POSSIBLE FORMATS COMPUTER     DF/HPFG     O        VERIFY DATA FLOW      Y      Y      Y     Y
POSSIBLE FORMATS                                                            SCHEDULES

.......................................................................................................................
```

ACTIVITY	INPUT/OUTPUT NAME	I/O FORM	SW ASSOC. WITH	TYPE	SOURCE/DESTINATION	CYCLES INPUT/OUTPUT DURING PREL	BASIC	UPDT	RPLNG
SCHEDULE HRM FORMATS AND DOWNLINK	MASTER FILE	COMPUTER	DF/HFS	I	SCHEDULE ONBOARD RECORDER OPERATIONS	Y	Y	Y	Y
SCHEDULE HRM FORMATS AND DOWNLINK	DATA FLOW INPUT VARIABLES	COMPUTER	DF/HFS	I	MISSION SUPPORT ACTIVITIES INPUT VARIABLES	Y	Y	Y	Y
SCHEDULE HRM FORMATS AND DOWNLINK	DFA SCHEDULAR CMNDS	COMPUTER	DF/HFS	I	MANUAL FEEDBACK TO UPDATE SCHEDULES BASED ON EVALUATION OF ERROR FILE	Y	Y	Y	Y
SCHEDULE HRM FORMATS AND DOWNLINK	HRM FORMATS DEFN	COMPUTER	DF/HFS	I	HRM FORMATS DEFINITION	Y	Y	Y	Y
SCHEDULE HRM FORMATS AND DOWNLINK	HRM POSSIBLE FORMATS	COMPUTER	DF/HFS	I	GENERATE HRM POSSIBLE FORMATS	Y	Y	Y	Y
SCHEDULE HRM FORMATS AND DOWNLINK	PROFILE	COMPUTER	DF/HFS	I	GENERATE MISSION DATA REQUIREMENTS PROFILE	Y	Y	Y	Y
SCHEDULE HRM FORMATS AND DOWNLINK	HFS ERROR	COMPUTER	DF/HFS	O	DATA FLOW ANALYSIS ENGINEERS FOR EVALUATION	Y	Y	Y	Y
SCHEDULE HRM FORMATS AND DOWNLINK	MASTER FILE	COMPUTER	DF/HFS	O	GENERATE POCC POSSIBLE CONFIGURATIONS	Y	Y	Y	Y
GENERATE POCC POSSIBLE CONFIGURATIONS	MASTER FILE	COMPUTER	DF/PPCG	I	SCHEDULE HRM FORMATS AND DOWNLINK	Y	Y	Y	Y

ACTIVITY	INPUT/OUTPUT NAME	I/O FORM	SW ASSOC. WITH	TYPE	SOURCE/DESTINATION	CYCLES INPUT/OUTPUT DURING PREL	BASIC	UPDT	RPLNG
GENERATE POCC POSSIBLE CONFIGURATIONS	DATA FLOW INPUT VARIABLES	COMPUTER	DF/PPCG	I	MISSION SUPPORT ACTIVITIES INPUT VARIABLES	Y	Y	Y	Y
GENERATE POCC POSSIBLE CONFIGURATIONS	PROFILE	COMPUTER	DF/PPCG	I	GENERATE MISSION DATA REQUIREMENTS PROFILE	Y	Y	Y	Y
GENERATE POCC POSSIBLE CONFIGURATIONS	POCC CONFIG DEFN	COMPUTER	DF/PPCG	I	POCC CONFIGURATION DEFINITION	Y	Y	Y	Y
GENERATE POCC POSSIBLF CONFIGURATIONS	DFA SCHEDULAR CMNDS	COMPUTER	DF/PPCG	I	MANUAL FEEDBACK TO UPDATE SCHEDULES BASED ON EVALUATION OF ERROR FILES	Y	Y	Y	Y
GENERATE POCC POSSIBLE CONFIGURATIONS	POCC POSSIBLE CONFIG	COMPUTER	DF/PPCG	O	SCHEDULE POCC CONFIGURATIONS	Y	Y	Y	Y
GENERATE POCC POSSIBLE CONFIGURATIONS	POCC POSSIBLE CONFIG	COMPUTER	DF/PPCG	O	SCHEDULE RECORDER PLAYBACKS	Y	Y	Y	Y
SCHEDULE POCC CONFIGURATIONS	POCC POSSIBLE CONFIG	COMPUTER	DF/PCS	I	GENERATE POCC POSSIBLE CONFIGURATIONS	Y	Y	Y	Y
SCHEDULE POCC CONFIGURATIONS	POCC CONFIG DEFN	COMPUTER	DF/PCS	I	POCC CONFIGURATION DEFINITION	Y	Y	Y	Y
SCHEDULE POCC CONFIGURATIONS	MASTER FILE	COMPUTER	DF/PCS	I	SCHEDULE HRM FORMATS AND DOWNLINK	Y	Y	Y	Y

ACTIVITY INPUT/OUTPUTS

ACTIVITY	INPUT/OUTPUT NAME	I/O FORM	SW ASSOC. WITH	TYPE	SOURCE/DESTINATION	CYCLES INPUT/OUTPUT DURING			
						PREL	BASIC	UPDT	RPLNG
SCHEDULE POCC CONFIGURATIONS	HRM FORMATS DEFN	COMPUTER	DF/PCS	I	HRM FORMATS DEFINITION	Y	Y	Y	Y
SCHEDULE POCC CONFIGURATIONS	DATA FLOW INPUT VARIABLES	COMPUTER	DF/PCS	I	MISSION SUPPORT ACTIVITIES INPUT VARIABLES	Y	Y	Y	Y
SCHEDULE POCC CONFIGURATIONS	MASTER FILE	COMPUTER	DF/PCS	O	SCHEDULE RECORDER PLAYBACKS	Y	Y	Y	Y
SCHEDULE RECORDER PLAYBACKS	PROFILE	COMPUTER	DF/PBS	I	GENERATE MISSION DATA REQUIREMENTS PROFILE	Y	Y	Y	Y
SCHEDULE RECORDER PLAYBACKS	MASTER FILE	COMPUTER	DF/PBS	I	SCHEDULE POCC CONFIGURATIONS	Y	Y	Y	Y
SCHEDULE RECORDER PLAYBACKS	DATA FLOW INPUT VARIABLES	COMPUTER	DF/PBS	I	MISSION SUPPORT ACTIVITIES INPUT VARIABLES	Y	Y	Y	Y
SCHEDULE RECORDER PLAYBACKS	POCC POSSIBLE CONFIG	COMPUTER	DF/PBS	I	GENERATE POCC POSSIBLE CONFIGURATIONS	Y	Y	Y	Y
SCHEDULE RECORDER PLAYBACKS	DFA SCHEDULAR CMNDS	COMPUTER	DF/PBS	I	MANUAL FEEDBACK TO UPDATE SCHEDULES BASED ON EVALUATION OF ERROR FILES	Y	Y	Y	Y
SCHEDULE RECORDER PLAYBACKS	PBS ERROR	COMPUTER	DF/PBS	O	DATA FLOW ANALYSIS ENGINEERS FOR EVALUATION	Y	Y	Y	Y

ACTIVITY	INPUT/OUTPUT NAME	I/O FORM	SW ASSOC. WITH	TYPE	SOURCE/DESTINATION	CYCLES INPUT/OUTPUT DURING PREL	BASIC	UPDT	RPLNG
SCHEDULE RECORDER PLAYBACKS	MASTER FILE	COMPUTER	DF/PBS	O	GENERATE DATA FLOW REPORTS	Y	Y	Y	Y
SCHEDULE RECORDER PLAYBACKS	MASTER FILE	COMPUTER	DF/PBS	O	VERIFY DATA FLOW SCHEDULES	Y	Y	Y	Y
SCHEDULE RECORDER PLAYBACKS	POCC POSSIBLE CONFIG	COMPUTER	DF/PBS	O	VERIFY DATA FLOW SCHEDULES	Y	Y	Y	Y
SCHEDULE RECORDER PLAYBACKS	MASTER FILE	COMPUTER	DF/PBS	O	UPDATE OR ENHANCE EXISTING SCHEDULES	Y	Y	Y	Y
VERIFY DATA FLOW SCHEDULES	COMM AC/LOS	COMPUTER	DF/DVM	I	PROCESS TDRS DATA FOR ENHANCEMENT	Y	Y	Y	Y
VERIFY DATA FLOW SCHEDULES	MASTER FILE	COMPUTER	DF/DVM	I	SCHEDULE RECORDER PLAYBACKS	Y	Y	Y	Y
VERIFY DATA FLOW SCHEDULES	MISSION WINDOWS	COMPUTER	DF/DVM	I	GENERATE MISSION WINDOWS	Y	Y	Y	Y
VERIFY DATA FLOW SCHEDULES	HRM POSSIBLE FORMATS	COMPUTER	DF/DVM	I	GENERATE HRM POSSIBLE FORMATS	Y	Y	Y	Y
VERIFY DATA FLOW SCHEDULES	POCC POSSIBLE CONFIG	COMPUTER	DF/DVM	I	SCHEDULE RECORDER PLAYBACKS	Y	Y	Y	Y
VERIFY DATA FLOW SCHEDULES	HRM FORMATS DEFN	COMPUTER	DF/DVM	I	HRM FORMATS DEFINITION	Y	Y	Y	Y
VERIFY DATA FLOW SCHEDULES	SPECIFIC CHECKS	MANUAL	DF/DVM	I	DATA FLOW ANALYSIS ENGINEERS COMMAND CHECK OF SPECIFIC FILES	Y	Y	Y	Y

```
                                                     SW ASSOC.                                     CYCLES INPUT/OUTPUT DURING
ACTIVITY             INPUT/OUTPUT NAME     I/O FORM    WITH      TYPE       SOURCE/DESTINATION      PREL  BASIC UPDT RPLNG
-------------------- -------------------- ---------- ---------- ---------- ---------------------- ----  ----- ---- -----
VERIFY DATA FLOW     VERIFY ERROR          COMPUTER   DF/DVM     O          DATA FLOW ANALYSIS      Y     Y     Y     Y
SCHEDULES                                                                   ENGINEERS FOR
                                                                            EVALUATION

GENERATE DATA FLOW   DATA MANGMT           COMPUTER   DF/DFRG    I          GENERATE DATA FLOW      Y     Y     Y     Y
REPORTS              CHECKLIST (PREV)                                       REPORTS (PREVIOUS
                                                                            CYCLE)

GENERATE DATA FLOW   DATA FLOW INPUT       COMPUTER   DF/DFRG    I          MISSION SUPPORT         Y     Y     Y     Y
REPORTS              VARIABLES                                              ACTIVITIES INPUT
                                                                            VARIABLES

GENERATE DATA FLOW   PROFILE               COMPUTER   DF/DFRG    I          GENERATE MISSION DATA   Y     Y     Y     Y
REPORTS                                                                     REQUIREMENTS PROFILE

GENERATE DATA FLOW   MASTER FILE           COMPUTER   DF/DFRG    I          SCHEDULE RECORDER       Y     Y     Y     Y
REPORTS                                                                     PLAYBACKS

GENERATE DATA FLOW   EXPERIMENT HEADER     COMPUTER   DF/DFRG    I          MANUAL INPUT OF         Y     Y     Y     Y
REPORTS                                                                     DEDICATED CHANNELS
                                                                            AND EXPERIMENT ID'S

GENERATE DATA FLOW   HRM POSSIBLE FORMATS  COMPUTER   DF/DFRG    I          GENERATE HRM POSSIBLE   Y     Y     Y     Y
REPORTS                                                                     FORMATS

GENERATE DATA FLOW   COMM AC/LOS           COMPUTER   DF/DFRG    I          PROCESS TDRS DATA FOR   Y     Y     Y     Y
REPORTS                                                                     ENHANCEMENT

GENERATE DATA FLOW   TABULAR REPORTS       COMPUTER   DF/DFRG    O          MISSION SUPPORT         Y     Y     Y     Y
REPORTS                                                                     PERSONNEL

GENERATE DATA FLOW   DATA FLOW SCHED       COMPUTER   DF/DFRG    O          GENERATE PTS CHARTS     Y     Y     Y     Y
REPORTS

------------------------------------------------------------------------------------------------------------------------
```

ACTIVITY	INPUT/OUTPUT NAME	I/O FORM	SW ASSOC. WITH	TYPE	SOURCE/DESTINATION	CYCLES INPUT/OUTPUT DURING PREL	BASIC	UPDT	RPLNG
GENERATE DATA FLOW REPORTS	COMPARED DATA MGMT CHECKLIST	COMPUTER	DF/DFRG	O	DATA FLOW ANALYSTS	Y	Y	Y	Y
GENERATE DATA FLOW REPORTS	DATA MANGMT CHECKLIST	COMPUTER	DF/DFRG	O	POCC SUPPORT	N	N	Y	Y
GENERATE DATA FLOW REPORTS	DATA FLOW SCHED	COMPUTER	DF/DFRG	O	GENERATE PCAP CHARTS	N	Y	Y	Y
GENERATE DATA FLOW REPORTS	DATA FLOW SCHED	COMPUTER	DF/DFRG	O	GENERATE POCC CHECKLIST AND COMMAND TIMELINES	N	Y	Y	Y
GENERATE DATA FLOW REPORTS	DATA FLOW SCHED	COMPUTER	DF/DFRG	O	GENERATE COMMAND TIMELINE	N	Y	Y	Y
UPDATE OR ENHANCE EXISTING SCHEDULES	PROFILE	COMPUTER	IDUS	I	GENERATE MISSION DATA REQUIREMENTS PROFILE	Y	Y	Y	Y
UPDATE OR ENHANCE EXISTING SCHEDULES	DATA FLOW INPUT VARIABLES	COMPUTER	IDUS	I	MISSION SUPPORT ACTIVITIES INPUT VARIABLES	Y	Y	Y	Y
UPDATE OR ENHANCE EXISTING SCHEDULES	HRM FORMATS DEFN	COMPUTER	IDUS	I	HRM FORMATS DEFINITION	Y	Y	Y	Y
UPDATE OR ENHANCE EXISTING SCHEDULES	COMM AC/LOS	COMPUTER	IDUS	I	PROCESS TDRS DATA FOR ENHANCEMENT	Y	Y	Y	Y
UPDATE OR ENHANCE EXISTING SCHEDULES	MASTER FILE	COMPUTER	IDUS	I	SCHEDULE RECORDER PLAYBACKS	Y	Y	Y	Y

ACTIVITY INPUT/OUTPUTS

ACTIVITY	INPUT/OUTPUT NAME	I/O FORM	SW ASSOC. WITH	TYPE	SOURCE/DESTINATION	CYCLES INPUT/OUTPUT DURING PREL	BASIC	UPDT	RPLNG
UPDATE OR ENHANCE EXISTING SCHEDULES	MODIFICATIONS	MANUAL	IDUS	I	MODIFICATIONS TO SCHEDULES BASED ON USER EXPERIENCE	Y	Y	Y	Y
UPDATE OR ENHANCE EXISTING SCHEDULES	MASTER FILE	COMPUTER	IDUS	O	VERIFY DATA FLOW SCHEDULES	Y	Y	Y	Y
UPDATE OR ENHANCE EXISTING SCHEDULES	MASTER FILE	COMPUTER	IDUS	O	GENERATE DATA FLOW REPORTS	Y	Y	Y	Y
CREATE SUBORDINATE TIMELINES	O&IA	MANUAL	EDT	I	PAYLOAD DATA COLLECTION	N	Y	N	N
CREATE SUBORDINATE TIMELINES	INPUTS FROM PI'S	MANUAL	EDT	I	PI REQMTS INPUT	N	Y	N	N
CREATE SUBORDINATE TIMELINES	ITL	COMPUTER	EDT	O	CHECK STL SYNTAX	N	Y	N	N
CHECK STL SYNTAX	ITL	COMPUTER	VERSTL	I	CREATE SUBORDINATE TIMELINES	N	Y	N	N
CHECK STL SYNTAX	SUB TL	COMPUTER	VERSTL	O	GENERATE STL BUFFER UTILIZATION REPORT	N	Y	N	N
CHECK STL SYNTAX	STL PRINTOUTS	COMPUTER	VERSTL	O	DESKTOP STL OPERATIONAL VERIFICATION	N	Y	N	N
DESKTOP STL OPERATIONAL VERIFICATION	STL PRINTOUTS	MANUAL	NONE	I	CHECK STL SYNTAX	N	Y	N	N

ACTIVITY	INPUT/OUTPUT NAME	I/O FORM	SW ASSOC. WITH	TYPE	SOURCE/DESTINATION	CYCLES INPUT/OUTPUT DURING PREL	BASIC	UPDT	RPLNG
DESKTOP STL OPERATIONAL VERIFICATION	UPDATES TO STL'S	MANUAL	NONE	O	CREATE SUBORDINATE TIMELINES	N	Y	N	N
CREATE MASTER INPUT FILES	ESS TARGET PRINTOUTS	MANUAL	EDT	I	CREATE ESS TARGET FILE	N	Y	N	N
CREATE MASTER INPUT FILES	O&IA	MANUAL	EDT	I	PAYLOAD DATA COLLECTION	N	Y	N	N
CREATE MASTER INPUT FILES	EXP T/L PRINTOUTS	MANUAL	EDT	I	FINALIZE MISSION TIMELINE	N	Y	N	N
CREATE MASTER INPUT FILES	INPUTS FROM PI'S	MANUAL	EDT	I	PI REQMTS INPUT	N	Y	N	N
CREATE MASTER INPUT FILES	MI	COMPUTER	EDT	O	VERIFY MASTER INPUT FILES	N	Y	N	N
VERIFY AND COMBINE MASTER INPUT FILES	MI	COMPUTER	VERMI	I	CREATE MASTER INPUT FILES	N	Y	N	N
VERIFY AND COMBINE MASTER INPUT FILES	MI	COMPUTER	VERMI	O	GENERATE MASTER TIMELINE	N	Y	N	N
GENERATE MASTER TIMELINE	EXP T/L	COMPUTER	GENMTL	I	FINALIZE MISSION TIMELINE	N	Y	N	N
GENERATE MASTER TIMELINE	MI	COMPUTER	GENMTL	I	VERIFY AND COMBINE MASTER INPUT FILES	N	Y	N	N
GENERATE MASTER TIMELINE	ESS TARGET	COMPUTER	GENMTL	I	CREATE ESS TARGET FILE	N	Y	N	N

```
                                                     SW ASSOC.                                      CYCLES INPUT/OUTPUT DURING
ACTIVITY              INPUT/OUTPUT NAME     I/O FORM    WITH     TYPE        SOURCE/DESTINATION     PREL   BASIC  UPDT  RPLNG
--------------------  --------------------  ----------  ----------  ----------  --------------------  ----   -----  ----  -----
GENERATE MASTER       MTL                   COMPUTER    GENMTL      O           VERIFY MASTER          N      Y      N     N
TIMELINE                                                                        TIMELINE

VERIFY MASTER         MTL                   COMPUTER    VERMTL      I           GENERATE MASTER        N      Y      N     N
TIMELINE                                                                        TIMELINE

VERIFY MASTER         MTL                   COMPUTER    VERMTL      O           GENERATE STL BUFFER    N      Y      N     N
TIMELINE                                                                        UTILIZATION REPORT

GENERATE STL BUFFER   SUB TL                COMPUTER    STLBUF      I           DESKTOP STL            N      Y      N     N
UTILIZATION REPORT                                                              OPERTIONAL
                                                                                VERIFICATION

GENERATE STL BUFFER   MTL                   COMPUTER    STLBUF      I           VERIFY MASTER          N      Y      N     N
UTILIZATION REPORT                                                              TIMELINE

GENERATE STL BUFFER   ECOS TL PRINTOUTS     COMPUTER    STLBUF      O           DESKTOP MTL            N      Y      N     N
UTILIZATION REPORT                                                              OPERATIONAL
                                                                                VERIFICATION

GENERATE STL BUFFER   ECOS TL               COMPUTER    STLBUF      O           CONVERT TO IBM TAPE    N      Y      N     N
UTILIZATION REPORT                                                              FORMAT AND VERIFY

GENERATE STL BUFFER   ECOS TL               COMPUTER    STLBUF      O           CREATE MMU ALLOCATION  N      Y      N     N
UTILIZATION REPORT                                                              FILE

DESKTOP MTL           ECOS TL PRINTOUTS     MANUAL      NONE        I           GENERATE STL BUFFER    N      Y      N     N
OPERATIONAL                                                                     UTILIZATION REPORT
VERIFICATION

DESKTOP MTL           UPDATES TO MASTER     MANUAL      NONE        O           CREATE MASTER INPUT    N      Y      N     N
OPERATIONAL           INPUT FILES                                               FILES
VERIFICATION

-----------------------------------------------------------------------------------------------------------------------------
```

```
                                                      SW ASSOC.                                        CYCLES INPUT/OUTPUT DURING
ACTIVITY              INPUT/OUTPUT NAME     I/O FORM    WITH       TYPE        SOURCE/DESTINATION     PREL  BASIC  UPDT  RPLNG
--------------------  --------------------  ----------  ---------  ----------  ---------------------  ----  -----  ----  -----
CONVERT TO IBM TAPE   ECOS TL               COMPUTER    DEL.COM.   I           GENERATE STL BUFFER    N     Y      N     N
FORMAT AND VERIFY                                                              UTILIZATION REPORT

CONVERT TO IBM TAPE   PRINTOUT OF ECOS      COMPUTER    DEL.COM.   O           GENERATE ECOS          N     Y      N     N
FORMAT AND VERIFY     TIMELINE                                                 TIMELINE DOCUMENT

CONVERT TO IBM TAPE   ECOS TL (EBCDIC)      COMPUTER    DEL.COM.   O           ECOS TAPE BUILD (STS   N     Y      N     N
FORMAT AND VERIFY                                                              ACTIVITIES)

GENERATE ECOS         PRINTOUT OF ECOS      MANUAL      NONE       I           CONVERT TO IBM FORMAT  N     Y      N     N
TIMELINE DOCUMENT     TIMELINE                                                 AND VERIFY

GENERATE ECOS         ECOS TIMELINE         MANUAL      NONE       O           MISSION SUPPORT        N     Y      N     N
TIMELINE DOCUMENT     DOCUMENT                                                 PERSONNEL

CREATE MMU            DDU DISPLAYS          COMPUTER    EDT        I           STS ACTIVITIES INPUTS  N     Y      N     N
ALLOCATION FILE                                                                (MSFC)

CREATE MMU            ECOS TL               COMPUTER    EDT        I           GENERATE STL BUFFER    N     Y      N     N
ALLOCATION FILE                                                                UTILIZATION REPORT

CREATE MMU            PRELIM MMU MAP        MANUAL      EDT        I           STS ACTIVITIES INPUTS  N     Y      N     N
ALLOCATION FILE                                                                (MSFC)

CREATE MMU            MMU ALLOCATION        COMPUTER    EDT        O           EVALUATE MMU TAPE      N     Y      N     N
ALLOCATION FILE                                                                MOVEMENT

EVALUATE MMU TAPE     MMU ALLOCATION        COMPUTER    MMUALL     I           CREATE MMU ALLOCATION  N     Y      N     N
MOVEMENT                                                                       FILE

EVALUATE MMU TAPE     ECOS TL               COMPUTER    MMUALL     I           GENERATE STL BUFFER    N     Y      N     N
MOVEMENT                                                                       UTILIZATION REPORT

-----------------------------------------------------------------------------------------------------------------------------
```

ACTIVITY INPUT/OUTPUTS

ACTIVITY	INPUT/OUTPUT NAME	I/O FORM	SW ASSOC. WITH	TYPE	SOURCE/DESTINATION	CYCLES INPUT/OUTPUT DURING			
						PREL	BASIC	UPDT	RPLNG
EVALUATE MMU TAPE MOVEMENT	MMU ALLOCATION PRINTOUT	COMPUTER	MMUALL	O	MISSION SUPPORT PERSONNEL	N	Y	N	N
EVALUATE MMU TAPE MOVEMENT	MMU OPTIMIZATION REPORT	COMPUTER	MMUALL	O	MMU ENGINEERS FOR EVALUATION	N	Y	N	N
CREATE COMMAND LIST	COMMANDS FROM PI	MANUAL	EDT	I	P.I. (PRINCIPAL INVESTIGATOR)	N	Y	Y	Y
CREATE COMMAND LIST	COMMAND.INP	COMPUTER	EDT	O	CHECK COMMAND SYNTAX	N	Y	Y	Y
CHECK COMMAND SYNTAX	COMMAND.INP	COMPUTER	CHECK	I	CREATE COMMAND LIST	N	Y	Y	Y
CHECK COMMAND SYNTAX	COMMAND.VFY	COMPUTER	CHECK	O	PRODUCE COMMAND TIMETAGS	N	Y	Y	Y
PRODUCE COMMAND TIMETAGS	COMMAND.VFY	COMPUTER	MET	I	CHECK COMMAND SYNTAX	N	Y	Y	Y
PRODUCE COMMAND TIMETAGS	COMMAND.FIN	COMPUTER	MET	O	GENERATE COMMAND TIMELINE	N	Y	Y	Y
GENERATE COMMAND TIMELINE	DATA FLOW SCHED	COMPUTER	CMDATG	I	GENERATE DATA FLOW REPORTS	N	Y	Y	Y
GENERATE COMMAND TIMELINE	COMMAND.FIN	COMPUTER	CMDATG	I	PRODUCE COMMAND TIMETAGS	N	Y	Y	Y
GENERATE COMMAND TIMELINE	ESS TARGET	COMPUTER	CMDATG	I	CREATE ESS TARGET FILE	N	Y	Y	Y
GENERATE COMMAND TIMELINE	COMMAND T/L	COMPUTER	CMDATG	O	GENERATE POCC CHECKLIST AND COMMAND TIMELINE	N	Y	Y	Y

ACTIVITY INPUT/OUTPUTS

ACTIVITY	INPUT/OUTPUT NAME	I/O FORM	SW ASSOC. WITH	TYPE	SOURCE/DESTINATION	CYCLES INPUT/OUTPUT DURING PREL	BASIC	UPDT	RPLNG
CREATE POCC CHECKLIST	MSN SUPPORT PERSONNEL/POH INPUTS	MANUAL	EDT	I	MISSION SUPPORT PERSONNEL AND POH	N	Y	Y	Y
CREATE POCC CHECKLIST	ACTIVITY.INP	COMPUTER	EDT	O	CHECK ACTIVITY SYNTAX	N	Y	Y	Y
CHECK ACTIVITY SYNTAX	ACTIVITY.INP	COMPUTER	CHECK	I	CREATE POCC CHECKLIST	N	Y	Y	Y
CHECK ACTIVITY SYNTAX	ACTIVITY.VFY	COMPUTER	CHECK	O	PRODUCE ACTIVITY TIMETAGS	N	Y	Y	Y
PRODUCE ACTIVITY TIMETAGS	ACTIVITY.VFY	COMPUTER	MET	I	CHECK ACTIVITY SYNTAX	N	Y	Y	Y
PRODUCE ACTIVITY TIMETAGS	POCC.FIN	COMPUTER	MET	O	GENERATE POCC CHECKLIST AND COMMAND TIMELINE	N	Y	Y	Y
GENERATE POCC CHECKLIST AND COMMAND TIMELINE	DATA FLOW SCHED	COMPUTER	CG	I	GENERATE DATA FLOW REPORTS	N	Y	Y	Y
GENERATE POCC CHECKLIST AND COMMAND TIMELINE	ESS TARGET	COMPUTER	CG	I	CREATE ESS TARGET FILE	N	Y	Y	Y
GENERATE POCC CHECKLIST AND COMMAND TIMELINE	ATT TL	COMPUTER	CG	I	EDIT TO INCORPORATE STS OR OTHER REQMTS (DS)	N	Y	Y	Y
GENERATE POCC CHECKLIST AND COMMAND TIMELINE	EXP T/L	COMPUTER	CG	I	FINALIZE MISSION TIMELINE	N	Y	Y	Y

ACTIVITY	INPUT/OUTPUT NAME	I/O FORM	SW ASSOC. WITH	TYPE	SOURCE/DESTINATION	CYCLES INPUT/OUTPUT DURING PREL	BASIC	UPDT	RPLNG
GENERATE POCC CHECKLIST AND COMMAND TIMELINE	COMMAND T/L	COMPUTER	CG	I	GENERATE COMMAND TIMELINE	N	Y	Y	Y
GENERATE POCC CHECKLIST AND COMMAND TIMELINE	POCC.FIN	COMPUTER	CG	I	PRODUCE ACTIVITY TIMETAGS	N	Y	Y	Y
GENERATE POCC CHECKLIST AND COMMAND TIMELINE	ATT TL	COMPUTER	CG	I	EDIT CURRENT ATTITUDE T/L TO INCORPORATE STS OR OTHER REQMTS	N	Y	Y	Y
GENERATE POCC CHECKLIST AND COMMAND TIMELINE	POCC CHECKLIST & COMMAND T/L	COMPUTER	CG	O	POCC CADRE	N	Y	Y	Y

TABLE 7
COMPUTER INPUT/OUTPUT SUMMARY

```
                            COMPUTER INPUT/OUTPUT SUMMARY              DATE 03/18/87

                                                                       PAGE        1

                                   FILE SIZE(BYTES)
                                                       INPUT/OUTPUT DESCRIPTION
INPUT/OUTPUT NAME                 MAXIMUM     MINIMUM
-----------------------------    ----------  ----------  ----------------------------------------
ACTIVITY.INP                          61440       12288  ACTIVITY CARDS, INITIATOR CARDS,
                                                         TERMINATION CARDS.

ACTIVITY.VFY                          61440       12288  ACTIVITY CARDS, INITIATOR CARDS,
                                                         TERMINATION CARDS.

ANG'LR DIST'CE                      1024000      747520  THIS IS AN ASCII FILE CONTAINING A MATRIX
                                                         OF THE ANGULAR DISTANCE BETWEEN EACH
                                                         TARGET AND ALL OTHERS.  THERE ARE NO
                                                         OTHER PARAMETERS ON THE FILE AND THE
                                                         POSITION IN THE MATRIX CORRESPONDS TO A
                                                         GIVEN TARGET.

ASCN NODE                            409600      245760  THIS IS A LIST-DIRECTED FILE CONTAINING
                                                         DETAILED ORBITAL EPHEMERIS DATA (SAME AS
                                                         DETAILED EPHEMERIS FILE) FOR EACH ORBIT
                                                         AT THE TIME OF ASCENDING NODE.

AT PHY CONSTS                        204800      102400  THIS IS AN ON/OFF FILE CONTAINING ON/OFF
                                                         TIMES WHICH REPRESENT TIME PERIODS WHERE
                                                         CERTAIN ATMOSPHERIC PHYSICS
                                                         REQUIREMENTS/CONSTRAINTS HAVE BEEN
                                                         SATISFIED.  THIS IS A SUBJECT TYPE 0
                                                         ON/OFF FILE.

AT PHY TARGETS                       204800      102400  THIS IS AN ON/OFF FILE CONTAINING
                                                         ATMOSPHERIC PHYSICS TARGETS AFTER
                                                         REQUIRMENTS/CONSTRAINTS HAVE BEEN
                                                         COMBINED (BY UNION, INTERSECTION, OR
                                                         COMPLEMENT).  THIS IS A SUBJECT TYPE 0
                                                         ON/OFF FILE.
------------------------------------------------------------------------------------------------
```

```
                                 FILE SIZE(BYTES)
INPUT/OUTPUT NAME              MAXIMUM    MINIMUM    INPUT/OUTPUT DESCRIPTION
                                                     ----------------------------------------
----------------------------  ---------- ----------
ATT TL                            409600     102400  THIS IS AN ON/OFF FILE CONTAINING DATA
                                                     DEFINING THE ORBITER ATTITUDE TIMELINE.
                                                     THIS IS A SUBJECT TYPE 16 ON/OFF FILE.

ATT TL (NDF)                    10240000    1024000  THIS IS A NAME-DIRECTED FILE CONTAINING
                                                     DATA DEFINING THE ORBITER ATTITUDE
                                                     TIMELINE AND ASSOCIATED DATA.  INCLUDED
                                                     ARE ATTITUDE DATA, STATE VECTOR DATA,
                                                     TARGET DATA, SENSOR DATA, TIME, ATTITUDE
                                                     RATES DATA, KEYWORDS, AND MANEUVER TIMES.

BORB CONSTS                      1024000     512000  THIS IS AN ON/OFF FILE CONTAINING ON/OFF
                                                     TIMES WHICH REPRESENT TIME PERIODS WHERE
                                                     CERTAIN PLASMA PHYSICS
                                                     REQUIREMENTS/CONSTRAINTS HAVE BEEN
                                                     SATISFIED.  THIS IS A SUBJECT TYPE 0
                                                     ON/OFF FILE.

BORB PAR.                       14336000    4096000  THIS IS A LIST-DIRECTED FILE CONTAINING
                                                     TIME HISTORIES OF GEOMAGNETIC PARAMETERS.
                                                     THE DATA DEFINES THE STRENGTH OF THE
                                                     GEOMAGNETIC FIELD AND THE DIRECTIONS OF
                                                     THE FIELD AT THE CURRENT ORBITER
                                                     POSITION.

CAND GSTAR                       1024000     409600  THE CANDIDATE GUIDE STAR FILE CONTAINS
                                                     THE FOLLOWING INFORMATION FOR EACH GUIDE
                                                     STAR:  SCIENCE STAR SEQUENCE NUMBERS AND
                                                     ID NUMBERS, SCIENCE STAR RIGHT ASCENSION,
                                                     AND DECLINATION, IPS OPERATION MODE,
                                                     NUMBER OF GUIDE STARS IN
                                                     ANNULUS/BORESIGHT REGIONS, GUIDE STAR
                                                     LOCATION IN SKYMAP CATALOG, AND GUIDE
                                                     STAR POSITION (ANNULUS OR BORESIGHT).

--------------------------------------------------------------------------------------------
```

```
                                    COMPUTER INPUT/OUTPUT SUMMARY           DATE 03/18/87

                                                                            PAGE         3

                                     FILE SIZE(BYTES)
INPUT/OUTPUT NAME                  MAXIMUM     MINIMUM      INPUT/OUTPUT DESCRIPTION
---------------------------       ----------  ----------   ----------------------------------------
CASE STO                              204800      204800   ORBIT PARAMETERS STORED IN CASE STORAGE
                                                           FILES FOR NESP, ASEP, AND/OR TANRAY:
                                                           RADIUS (KM-NSEP) (M-ASEP), VELOCITY
                                                           (KM/S-NSEP) (M/S-ASEP), FLIGHT PATH ANGLE
                                                           (DEG), GEOCENTRIC LATITUDE (DEG),
                                                           LONGITUDE (DEG), INERTIAL AZIMUTH (DEG),
                                                           AND TIME (MET-HRS).

CEL TAR                               614400      368640   THIS IS A NAME-DIRECTED FILE CONTAINING
                                                           AN ARRAY DEFINING CANDIDATE CELESTIAL
                                                           TARGETS.  THE ARRAY CONTAINS TARGET NAME,
                                                           RIGHT ASCENSION, AND DECLINATION.

CEL TAR AC/LOS                      10240000     1024000   THIS IS AN ON/OFF FILE CONTAINING
                                                           CELESTIAL TARGET(S) ACQUISITION AND LOSS
                                                           TIMES.  THIS IS A SUBJECT TYPE 0 ON/OFF
                                                           FILE.

CEL TARGETS                         10240000     1024000   THIS IS AN ON/OFF FILE CONTAINING
                                                           CELESTIAL TARGETS AFTER
                                                           REQUIREMENTS/CONSTRAINTS HAVE BEEN
                                                           COMBINED (BY UNION, INTERSECTION, OR
                                                           COMPLEMENT). THIS IS A SUBJECT TYPE 0
                                                           ON/OFF FILE.

COMM AC/LOS                          1024000      737280   THIS IS AN ON/OFF FILE CONTAINING TDRS
                                                           AND GROUND STATION COMMUNICATION
                                                           INFORMATION.  INCLUDED ARE A TWO
                                                           SATELLITE TDRS SYSTEM (S-BAND OR K-BAND,
                                                           UP OR DOWN) AND 11 GROUND STATIONS.  THIS
                                                           FILE IS A COMBINATION OF SUBJECT TYPES
                                                           6,0, AND 1.

-------------------------------------------------------------------------------------------------------
```

```
                                      COMPUTER INPUT/OUTPUT SUMMARY            DATE 03/18/87

                                                                               PAGE          4

                                    FILE SIZE(BYTES)
INPUT/OUTPUT NAME                 MAXIMUM      MINIMUM     INPUT/OUTPUT DESCRIPTION
--------------------------      ----------   ----------    ----------------------------------------
COMMAND T/L                         102400        51200    LIST OF ALL COMMANDS BEING EXECUTED BY
                                                           FLIGHT SOFTWARE.

COMMAND.FIN                         102400        51200    ACTIVITY CARDS, INITIATOR CARDS,
                                                           TERMINATION CARDS.

COMMAND.INP                          61440        40960    ACTIVITY CARDS, INITIATOR CARDS,
                                                           TERMINATION CARDS.

COMMAND.VFY                          81440        40960    ACTIVITY CARDS, INITIATOR CARDS,
                                                           TERMINATION CARDS.

COMPARED DATA MGMT                -0-            204800    THE COMPARED DATA MANAGEMENT CHECKLIST
CHECKLIST                                                  CONTAINS DATA INDICATING THE DIFFERENCES
                                                           OF A CURRENT DATA MGMT CHECKLIST FILE  AS
                                                           COMPARED TO A PREVIOUS FILE. FLAGS
                                                           INDICATE WHETHER DATA ENTRIES HAVE BEEN
                                                           REPLACED (R), DELETED (D), OR ARE NEW
                                                           ENTRIES (N).

COO                                 409600       133120    THE COOBSERVATION FILE (PI DEVELOPED) IS
                                                           AN ASCII FILE CONTAINING DATA DEFINING
                                                           POTENTIAL CELESTIAL OBJECTS TO BE
                                                           OBSERVED DURING A MISSION.  DATA INCLUDES
                                                           NAME, ID, CLASS, PRIORITY, TIME,
                                                           CONTINUOUS/NON-CONTINUOUS, CONSTRAINTS,
                                                           RIGHT ASCENSION, DECLINATION, AND NUT
                                                           SLIT ANGLE.

CREW ACT                           1000000       100000    LISTING OF ON/OFF TIMES FOR EACH ACTIVITY
                                                           EACH CREWMAN PERFORMS.

----------------------------------------------------------------------------------------------------
```

```
                                  COMPUTER INPUT/OUTPUT SUMMARY              DATE 03/18/87

                                                                             PAGE          5

                                FILE SIZE(BYTES)
INPUT/OUTPUT NAME              MAXIMUM     MINIMUM     INPUT/OUTPUT DESCRIPTION
--------------------------     ----------  ----------  ----------------------------------------
DATA FLOW INPUT VARIABLES      -0-               2048  THE DATA FLOW INPUT VARIABLES FILE
                                                       CONTAINS A LIST OF THE VARIABLES COMMON
                                                       TO MANY OF THE DATA FLOW MODULES. THE
                                                       BASIC MISSION DESCRIPTION PLUS THE
                                                       CONFIGURATION OF THE MISSION DATA FLOW
                                                       ARE DEFINED BY MANIPULATING THE VALUES OF
                                                       THESE VARIABLES.

DATA FLOW MODELS               -0-             256000  THE DATA FLOW MODELS FILE CONTAINS DATA
                                                       WHICH CORRELATES THE EXPERIMENT FO'S AND
                                                       STEPS IN THE EXPERIMENT TIMELINE FILE TO
                                                       THE DATA REQUIREMENTS SETS  FOR THOSE
                                                       EXPERIMENTS IN THE DATA FLOW REQMTS FILE.

DATA FLOW REQMTS               -0-               2048  THE DATA FLOW REQUIREMENTS FILE CONTAINS
                                                       THE DATA REQUIREMENTS FOR EACH
                                                       EXPERIMENT. AN EXPERIMENT MAY HAVE MORE
                                                       THAN ONE SET OF REQMTS SINCE SOME HAVE
                                                       MULTIPLE FO'S.

DATA FLOW SCHED                -0-             409600  THE DATA FLOW SCHEDULE FILE CONTAINS DATA
                                                       DEFINING HDRR RECORD/DUMP TIMES, VIDEO
                                                       AND ANALOG DOWNLINK TIMES (REALTIME AND
                                                       DUMPS), ANALOG/VIDEO RECORDERS (1&2)
                                                       RECORD TIMES, HRM DOWNLINK FORMAT
                                                       SCHEDULE, TDRS HANDOVER AND/OR ONBOARD
                                                       RECONFIGURATION POINTS, AND ORBITER TV
                                                       CASSETTE RECORDERS (1&2) ACTIVITIES. THIS
                                                       FILE BECOMES PART OF THE MISSION FILE
                                                       DIRECTORY AND IS THE INTERFACE TO OTHER
                                                       MISSION PLANNING ORGANIZATIONS.

-----------------------------------------------------------------------------------------------
```

```
                                  FILE SIZE(BYTES)
INPUT/OUTPUT NAME              MAXIMUM     MINIMUM      INPUT/OUTPUT DESCRIPTION
---------------------------   ---------   ---------    ----------------------------------------
DATA MANGMT CHECKLIST          -0-          6144000    THE DATA MANAGEMENT CHECKLIST FILE
                                                       CONTAINS DATA WHICH PROVIDES AN OVERVIEW
                                                       OF ONBOARD RECORDERS, MRM FORMATS,
                                                       DOWNLINKS, EXP. DEDICATED CHANNELS, AND
                                                       POCC CONFIGURATION ACTIVITIES.

DATA MANGMT CHECKLIST          -0-          6144000    THE DATA MANAGEMENT CHECKLIST FROM A
(PREV)                                                 PREVIOUS CYCLE OR TIME. DATA CONTENT IS
                                                       THE SAME.

DDU DISPLAYS                     20480        12288    EXECUTABLE IMAGE OF ALL MITRA HEX
                                                       COMMANDS TO DDU.

DETAIL EPHEM                  24576000      8192000    THIS IS A LIST-DIRECTED FILE CONTAINING A
                                                       DETAILED TIME HISTORY OF ORBITAL
                                                       EPHEMERIS DATA.  AT EACH TIME POINT 110
                                                       PARAMETERS ARE COMPUTED INCLUDING THE
                                                       VEHICLE STATE VECTOR IN 3 DIFFERENT
                                                       COORDINATE SYSTEMS (SPHERICAL, POLAR AND
                                                       CARTESIAN), AND ORBITAL ELEMENTS.  ALSO
                                                       PROVIDED ARE VARIOUS PARAMETERS
                                                       DESCRIBING THE GEOMETRY OF ORBITAL
                                                       FLIGHT.

DFA SCHEDULAR CMNDS            -0-             2048    THE DFA SCHEDULAR FILE CONTAINS DATA TO
                                                       ALLOW THE USER AN OPTIONAL INPUT WHICH HE
                                                       MAY EMPLOY TO MODIFY THE NORMAL
                                                       SCHEDULING PROCESS. COMMANDS ALLOW THE
                                                       USER TO OVERRIDE THE BASIC SCHEDULAR
                                                       LOGIC IF AN UNUSUAL SITUATION IS
                                                       ENCOUNTERED.

-------------------------------------------------------------------------------------------------
```

```
                                 FILE SIZE(BYTES)
INPUT/OUTPUT NAME               MAXIMUM      MINIMUM     INPUT/OUTPUT DESCRIPTION
---------------------------     ----------   ----------  ----------------------------------------
EARTH SHADOW                         40960        30720  THIS IS AN ON/OFF FILE CONTAINING EARTH
                                                         SHADOW ACQUISITION AND LOSS TIMES.  THIS
                                                         IS A SUBJECT TYPE O ON/OFF FILE.

EARTH TARGETS                      1024000       512000  THIS IS AN ON/OFF FILE CONTAINING EARTH
                                                         OBSERVATION TARGETS AFTER
                                                         REQUIREMENTS/CONSTRAINTS HAVE BEEN
                                                         COMBINED (BY UNION, INTERSECTION, OR
                                                         COMPLEMENT). THIS IS A SUBJECT TYPE O
                                                         ON-OFF FILE.

ECOS T/L PRINTOUTS              -0-          -0-         PRINTOUT CONTAINS ALL ECOS MASTER AND
                                                         SUBORDINATE TIMELINES.

ECOS TL                             775296       455296  MASTER TIMELINE EVENTS, NET FOR ALL
                                                         MASTER TIMELINE EVENTS, SUBORDINATE
                                                         TIMELINE EVENTS, DELTA TIMES FOR ALL
                                                         SUBORDINATE TIMELINE EVENTS.

ECOS TL (EBCDIC)                    775296       455296  MASTER TIMELINE EVENT, NET FOR ALL MASTER
                                                         TIMELINE EVENTS, SUBORDINATE TIMELINE
                                                         EVENTS, DELTA TIMES FOR ALL SUBORDINATE
                                                         TIMELINE EVENTS

ESS MODEL                            34000         4000  PRIMARY INPUT FOR ESP. CONTAINS DATA
                                                         NECCESSARY TO SCHEDULE EXPERIMENTS FOR SL
                                                         MISSIONS. ESS MODEL FILES ARE CREATED AND
                                                         UPDATED BY VME. SCHEDULING CONTROL DATA
                                                         MAY ALSO BE CREATED OR UPDATED BY ESP.

ESS MODELS PRINTOUT             -0-          -0-         PRINTOUT OF THE ESS MODEL FILE.

-------------------------------------------------------------------------------------------------
```

```
                          COMPUTER INPUT/OUTPUT SUMMARY            DATE 03/18/87

                                                                   PAGE         8

                              FILE SIZE(BYTES)
INPUT/OUTPUT NAME            MAXIMUM    MINIMUM     INPUT/OUTPUT DESCRIPTION
-------------------------   ---------- ----------  ---------------------------------------
ESS TARGET                        1652       2400  PROVIDES TARGET AC/LOS TIMES AND PRESET
                                                   ATTITUDE TIMES WHICH ARE USED BY ESP.
                                                   CREATED AND EDITED USING TAE.

ESS TARGET PRINTOUT          -0-        -0-        PRINTOUT OF THE ESS TARGET FILE.

EXP                            1000000     100000  GIVES ALL ON/OFF TIMES OF EACH EXPERIMENT
                                                   FOR A PARTICULAR MISSION SCHEDULE.

EXP T/L                              0       1000  PRIMARY OUTPUT OF ESP. PROVIDES A
                                                   PERMANENT RECORD OF A SCHEDULE TO USE IN
                                                   DISPLAY PROGRAMS AND FOR INITIALIZATION.

EXP T/L PRINTOUTS            -0-        -0-        PRINTOUT OF THE EXP T/L FILE.

EXPERIMENT HEADER            -0-           102400  THE EXPERIMENT HEADER FILE CONTAINS DATA
                                                   REQUIRED TO RUN MANY OF THE REPORT
                                                   MODULES. THE FILE INCLUDES DEDICATED
                                                   CHANNELS AND RELATED EXPERIMENT ID'S,
                                                   ECIO SUBSETS AND RELATED EXPERIMENT ID'S,
                                                   AND USER ADDRESS SPACES AND RELATED
                                                   EXPERIMENT ID'S. THE FILE AIDS THE USER
                                                   IN DEFINING WHAT INFORMATION IS CONTAINED
                                                   IN THE REPORTS.

GND STA AC/LOS                  266240     102400  THIS IS AN ON/OFF FILE CONTAINING GROUND
                                                   STATION(S) ACQUISITION AND LOSS TIMES.
                                                   THIS IS A SUBJECT TYPE 1 ON/OFF FILE.

-------------------------------------------------------------------------------------------
```

```
                                  FILE SIZE(BYTES)
INPUT/OUTPUT NAME               MAXIMUM     MINIMUM     INPUT/OUTPUT DESCRIPTION
----------------------------   ----------  ----------   -----------------------------------------
GND TRK                           2048000     1433600   THIS IS A LIST-DIRECTED FILE CONTAINING A
                                                        TIME HISTORY OF DATA DEFINING THE GROUND
                                                        TRACK OF AN ORBITING VEHICLE.  THE FILE
                                                        CONTAINS MISSION ELAPSE TIME, GEODETIC
                                                        LATITUDE, LONGITUDE, REV NUMBER, INERTIAL
                                                        AZIMUTH, ALTITUDE, MANEUVER COUNTER,
                                                        PERGEE AND APOGEE ALTITUDE, AND BETA
                                                        ANGLE.

GSTAR CAT                         6144000     3072000   THE GSTAR CATALOG FILE CONTAINS THE
                                                        FOLLOWING TYPES OF INFORMATION:  SCIENCE
                                                        TARGET NAME, NUMBER, RIGHT ASCENSION,
                                                        DECLINATION, ASTRONOMICAL NAME, CLASS AND
                                                        SUBCLASS, PRIORITY, OBSERVATION LENGTH,
                                                        CONTINUOUS/NON-CONTINUOUS, VIEWING TARGET
                                                        TYPE (DAY, NIGHT, BOTH), ROLL, AND VISUAL
                                                        MAGNITUDE.  FOR GUIDE STARS; TOTAL
                                                        NUMBER, NUMBER IN BORESIGHT REGION, IPS
                                                        OPERATION MODE, DATE/TIME TARGET WAS
                                                        WRITTEN, RIGHT ASCENSION, DECINATION,
                                                        POSITION ANGLE, ANGULAR DISTANCE BETWEEN
                                                        GUIDE STAR AND TARGET STAR, VISUAL,
                                                        ULTRA-VIOLET, AND BLUE MAGNITUDES,
                                                        GALACTIC LATITUDE AND LONGITUDE, SKYMAP
                                                        NO., SPECTRAL CLASS, POSITION (BORESIGHT
                                                        OR ANNULUS).

HEMSPR CONSTS                      204800      102400   THIS IS AN ON/OFF FILE CONTAINING ON/OFF
                                                        TIMES WHICH REPRESENT TIME PERIODS WHERE
                                                        CERTAIN HEMISPHERE
                                                        REQUIREMENTS/CONSTRAINTS HAVE BEEN
                                                        SATISFIED. THIS IS A SUBJECT TYPE 0
                                                        ON/OFF FILE.

-------------------------------------------------------------------------------------------------
```

```
                                 COMPUTER INPUT/OUTPUT SUMMARY               DATE 03/18/87

                                                                             PAGE ,        10

                                   FILE SIZE(BYTES)
INPUT/OUTPUT NAME               MAXIMUM      MINIMUM     INPUT/OUTPUT DESCRIPTION  .
-------------------------      ----------   ----------   ------------------------------------------
HFS ERROR                       -0-            20480     THE HFS ERROR FILE CONTAINS ALL THE
                                                         SCHEDULING ERRORS AND WARNINGS
                                                         ENCOUNTERED BY THE HRM FORMAT SCHEDULAR
                                                         MODULE.

HRM FORMATS DEFN                -0-             4096     THE HRM FORMATS DEFINITION FILE CONTAINS
                                                         DATA DESCRIBING ALL THE HRM FORMATS
                                                         DEFINED FOR A MISSION. EACH FORMAT
                                                         DEFINES A CONFIGURATION OF THE HRM,
                                                         FORMAT RATES, AND ANY RECORDER
                                                         CAPABILITIES FOR EACH FORMAT.

HRM POSSIBLE FORMATS            -0-           204800     THE HRM POSSIBLE FORMATS FILE CONTAINS
                                                         DATA WHICH DEFINES TDRS COVERAGE AND
                                                         POSSIBLE HRM FORMATS FOR GIVEN MET'S.

ID LIST                           102400       40960     THIS IS AN ASCII FILE CONTAINING ALL THE
                                                         ID'S OF SCHEDULED TARGETS IN ORDER BY
                                                         THEIR NUMERICAL VALUE.

ID/SEQ LIST                       102400       40960     THIS IS AN ASCII FILE CONTAINING
                                                         SCHEDULED TARGET ID'S, SEQUENCE NUMBERS
                                                         AND OTHERS SUPPORTING DATA.

INHBT                           -0-             5000     CONTAINS DEFINITION OF ALL INHIBITS AND
                                                         THEIR ON/OFF TIMES.

IPOL                              204800      102400     THIS IS A LIST-DIRECTED FILE CONTAINING
                                                         DATA ON EACH POINTING IN TIME ORDER.
                                                         DATA INCLUDES: TIME, ELEVATION (IPS)
                                                         CROSS ELEVATION (IPS), ROLL (IPS),
                                                         OBJECTIVE LOAD NUMBER, RIGHT ASCENSION
                                                         AND DECLINATION, OBJECTIVE LOAD ROLL,
                                                         CELESTIAL ROLL, TARGET ID AND NAME.

-------------------------------------------------------------------------------------------------
```

```
                                 FILE SIZE(BYTES)
INPUT/OUTPUT NAME              MAXIMUM     MINIMUM     INPUT/OUTPUT DESCRIPTION
-------------------------      ----------  ----------  ----------------------------------------
IPS ROLL ANGLES                    153600      102400  THE IPS ROLL ANGLE FILE CONTAINS THE
                                                       FOLLOWING TYPES OF DATA: MISSION ELAPSE
                                                       TIME, STAR NAMES 1 AND 2, BORESIGHT STAR
                                                       RIGHT ASCENSION AND DECLINATION, RIGHT
                                                       TRACKER RIGHT ASCENSION AND DECLINATION,
                                                       IPS ELEVATION, CO-ELEVATION AND ROLL
                                                       ANGLES, CELESTIAL ROLL ANGLE (ALSO THIS
                                                       ANGLE PLUS/MINUS 30 DEG), ORBITER
                                                       ATTITUDE ANGLES, AND ATTITUDE REFERENCE
                                                       COORDINTE SYSTEM.

ITL                                   400         388  SUBORDINATE TIMELINE EVENTS, DELTA TIME
                                                       FROM ACTIVATION OF SUBORDINATE TIMELINES.

JOTF                               409600      307200  THIS IS A MITRA HEX FILE CONTAINING DATA
                                                       FOR THE JOINT OPERATIONS TARGET FILE
                                                       (ONBOARD DATA SET JOTF).  THESE DATA ARE
                                                       USED BY ONBOARD ECAS TASKS AND INCLUDE:
                                                       TARGET ID AND NAME, RIGHT ASCENSION,
                                                       DECLINATION, ROLL, EXPERIMENT SEQUENCE
                                                       NUMBERS, AND SIMILAR MOVING TARGET DATA.

JOTF VERIFICATION REPORT       -0-         -0-         PRINTOUT OF THE JOINT OPERATIONS TARGET
                                                       FILE (JOTF) DATA SET USED TO VERIFY THE
                                                       CONTENTS OF THE DATA SET.

JSC CAP                           1000000      100000  CONTAINS ALL THE CREW ACTIVITY SCHEDULED
                                                       AS WELL AS OTHER PERTINENT INFORMATION TO
                                                       BE USED AS INPUT TO THE JSC CAPS2 SYSTEM.
                                                       CREATED BY ESP.

-----------------------------------------------------------------------------------------------
```

```
                                 FILE SIZE(BYTES)
INPUT/OUTPUT NAME              MAXIMUM      MINIMUM      INPUT/OUTPUT DESCRIPTION
-------------------------     ---------    ---------    -------------------------------------
KEYW'RD                          2048000      1024000    THIS IS A NAME-DIRECTED FILE CONTAINING
                                                         AN ARRAY DEFINING KEYWORDS AND ASSOCIATED
                                                         ATTITUDE DATA.  THE ARRAY CONTAINS NUMBER
                                                         OF KEYWORDS, KEYWORD DESCRIPTION LIST,
                                                         ATTITUDE DATA LIST, AND KEYWORD LIST.

LAUNCH WINDOW/LAUNCH TIME      -0-          -0-          A PLOT (AND SUPPORTING DATA) WHICH
DATA                                                     DEFINES THE AVAILABLE LAUNCH WINDOW VS
                                                         DAY OF YEAR. THE PLOT OVERLAYS ALL
                                                         CONSTRAINTS TO PRODUCE THE WINDOW IMAGES.

MASTER FILE                    -0-               512000  THE MASTER FILE CONTAINS THE OVERALL DATA
                                                         FLOW PLAN. THIS INCLUDES RECORDER
                                                         FILL/DUMP PLANS, KU-BAND CHANNELS 2 AND 3
                                                         USAGE PROFILE, NRM FORMATS, SATELLITE
                                                         COVERAGE, DATA RATES, POCC
                                                         CONFIGURATIONS, AND A SUMMARY OF ANY LOST
                                                         DATA.

MDRPG ERROR                    -0-                20480  THE MDRPG ERROR FILE LISTS ALL THE ERRORS
                                                         ENCOUNTERED BY THE MISSION DATA
                                                         REQUIREMENTS GENERATOR MODULE.

MI                                 61440          20480  MASTER TIMELINE EVENTS, MET TIMES FOR ALL
                                                         EVENTS.

MISSION WINDOWS                -0-               512000  THE MISSION WINDOWS FILE CONTAINS WINDOWS
                                                         OF OPPORTUNITY FOR DATA DOWNLINKS AND
                                                         RECORDER DUMPS.

MMU ALLOCATION                      4096           2048  NAMES OF ALL FILES ON THE MMU AND A
                                                         LITTLE INFORMATION ABOUT ALL OF THEM.

-----------------------------------------------------------------------------------------------
```

```
                             FILE SIZE(BYTES)
INPUT/OUTPUT NAME           MAXIMUM     MINIMUM      INPUT/OUTPUT DESCRIPTION
--------------------------  ----------  ----------   ----------------------------------------
MMU ALLOCATION PRINTOUT     -0-         -0-          A PRINTOUT OF THE MMU ALLOCATION FILE
                                                     WHICH CONTAINS AN ORDERED LIST OF MMU
                                                     FILES AND SUPPORTING DATA.

MMU DAT SET                      40960       20480   THIS IS A MITRA HEX FILE CONTAINING DATA
                                                     FOR USE BY THE ONBOARD ECOS TIMELINE
                                                     MAINTENANCE SYSTEM.  DATA INCLUDES SUN
                                                     RISE/SET EVENTS, MOON RISE/SET EVENTS,
                                                     TDRS ACQUISITION AND LOSS TIMES, SUN
                                                     RIGHT ASCENSION AND DECLINATION, TIME OF
                                                     NODAL CROSSING, AND NODAL PERIOD.

MMU OPTIMIZATION REPORT     -0-         -0-          SUM OF TAPE MOVEMENT FOR THE MISSION AND
                                                     AN ORDERED LIST OF MMU FILE NAMES.

MOON RISE/SET                    40960       30720   THIS IS AN ON/OFF FILE CONTAINING MOON
                                                     RISE AND SET TIMES.  THIS IS A SUBJECT
                                                     TYPE O ON/OFF FILE

MSN IND TARGETS                 409600      204800   THIS IS AN ON/OFF FILE CONTAINING ALL
                                                     MISSION INDEPENDENT TARGETS. THESE
                                                     INCLUDE: SUN RISE/SET, MOON RISE/SET,
                                                     PRELIMINARY TDRS AC/LOS, GROUND STATION
                                                     AC/LOS, SOUTH ATLANTIC ANOMALY AC/LOS.
                                                     THIS IS A SUBJECT TYPE O ON/OFF FILE.

MSN T/L TABLES, PRINTOUTS   -0-         -0-          DETAILED TABULATIONS, PLOTS, AND
                                                     PRINTOUTS OF THE MISSION TIMELINE.

MSN TARGETS                     409600      204800   THIS IS AN ON/OFF FILE CONTAINING ALL THE
                                                     EXPERIMENT TARGET OPPORTUNITIES (ALL
                                                     DISCIPLINES REPRESENTED IN THE PAYLOAD
                                                     COMPLEMENT) FOR THE MISSION.

-------------------------------------------------------------------------------------------------
```

INPUT/OUTPUT NAME	FILE SIZE(BYTES) MAXIMUM	FILE SIZE(BYTES) MINIMUM	INPUT/OUTPUT DESCRIPTION
MTL	2048	2040	MASTER TIMELINE EVENTS. MET TIMES.
MVR TL	204800	122880	THIS IS AN ON/OFF FILE CONTAINING DATA DEFINING THE ORBITER MANEUVER TIMELINE. THIS IS A SUBJECT TYPE 16 ON/OFF FILE.
MWG ERROR	-0-	20480	THE MWG ERROR FILE LISTS ALL THE SCHEDULING COMMANDS THAT COULD NOT BE HONORED BY THE CREATE MISSION WINDOWS MODULE BECAUSE OF CONFLICTS.
NOTES	1600	700	DATABASE OF PCAP NOTES FOR USE IN GENERATING PCAP CHARTS.
NSEP EPHEM	81920	40960	THIS A LIST-DIRECTED FILE CONTAINING A TIME HISTORY OF VEHICLE POSITION AND VELOCITY, AND ORBITAL ELEMENTS.
OBJ LOAD	-0-	573440	THIS IS AN ASCII FILE CONTAINING GUIDE STAR OBJECTIVE LOAD DATA WHICH INCLUDES: IPS OPERATING MODE, OBJECTIVE LOAD NO'S, EXPERIMENT NO'S, TARGET ATTITUDE DATA, TRACKER SCAN DATA, SUN POSITION DATA, DIRECTION COSINE MATRIX FOR REFERENCE SYSTEM TRANSFORMATIONS, TRACKER FOV GUIDE STAR AVAILABILITY DATA, GUIDE STAR RIGHT ASCENSION AND DECLINATION, AND TRACKER COUNT RATE DATA.

```
                                FILE SIZE(BYTES)
INPUT/OUTPUT NAME            MAXIMUM     MINIMUM     INPUT/OUTPUT DESCRIPTION
--------------------------   ---------   ---------   -----------------------------------------
OBJ LOAD SUMMARY-SOLAR &     -0-         -0-         THE OBJECTIVE LOAD SUMMARY IS A PRINTOUT
STELLAR                                              CONTAINING THE FOLLOWING INFORMATION:
                                                     OBJECTIVE LOAD NUMBER, IPS PITCH AND YAW
                                                     OFFSET ANGLES, IPS CELESTIAL ROLL ANGLE,
                                                     IPS POINTING MODE, RIGHT STAR TRACKER
                                                     GUIDE STAR NAME, VISUAL MAGNITUDE, RIGHT
                                                     ASCENSION AND DECLINATION, LEFT STAR
                                                     TRACKER GUIDE STAR NAME, VISUAL
                                                     MAGNITUDE, RIGHT ASCENSION AND
                                                     DECLINATION, BEGIN AND END, DATE/TIME
                                                     THAT OBJECTIVE LOAD IS VALID.

OBS CONSTS                      102400       61440   THIS IS AN ON/OFF FILE CONTAINING ON/OFF
                                                     TIMES WHICH REPRESENT TIME PERIODS WHERE
                                                     CERTAIN EARTH OBSERVATION
                                                     REQUIREMENTS/CONSTRAINTS HAVE BEEN
                                                     SATISFIED.  THIS IS A SUBJECT TYPE O
                                                     ON/OFF FILE.

ORBITER OCCULT                  409600      358400   THIS FILE CONTAINS THE ORBITER OCCULATION
                                                     DATA RELATIVE TO THE TDRS ANTENNAS.  THIS
                                                     FILE IS OBTAINED FROM JSC.

ORS ERROR                    -0-             20480   THE ORS ERROR FILE LISTS ALL THE
                                                     SCHEDULING COMMANDS THAT COULD NOT BE
                                                     HONORED BY THE ONBOARD RECORDER SCHEDULAR
                                                     MODULE BECAUSE OF CONFLICTS.

PBS ERROR                    -0-             20480   THE PBS ERROR FILE CONTAINS ALL THE
                                                     SCHEDULING ERRORS AND WARNINGS
                                                     ENCOUNTERED BY THE PLAYBACK SCHEDULAR
                                                     MODULE.

-------------------------------------------------------------------------------------------
```

INPUT/OUTPUT NAME	FILE SIZE(BYTES) MAXIMUM	FILE SIZE(BYTES) MINIMUM	INPUT/OUTPUT DESCRIPTION
PCAP CHARTS	-0-	-0-	DETAILED 1-HR CHARTS PRODUCED ON A HIGH RESOLUTION LASER PRINTER WHICH BECOME PART OF THE PFDF. THE PLAN SHOWS THE PROCEDURES THE CREW EXECUTES AND ASSOCIATED NOTES. IT ALSO SHOWS AUXILIARY INFORMATION SUCH AS ORBIT ALTITUDE AND MANEUVERS, SUN/SHADOW, K- AND S-BAND COMMUNICATIONS, HRM FORMATS,RECORDER USAGE, ORBIT REV NUMBER, AND OTHER DATA.
PL PHY TARGETS	1024000	512000	THIS IS AN ON/OFF FILE CONTAINING PLASMA PHYSICS TARGETS AFTER REQUIREMENTS/CONSTRAINTS HAVE BEEN COMBINED (BY UNION, INTERSECTION, OR COMPLEMENT). THIS IS A SUBJECT TYPE O ON/OFF FILE.
POCC CHECKLIST & COMMAND T/L	-0-	-0-	PRINTOUT OF THE POCC CHECKLIST AND COMMAND TIMELINE.
POCC CONFIG DEFN	-0-	20480	THE POCC CONFIGURATION DEFINITION FILE CONTAINS DATA DEFINING EACH PARTICULAR ROUTING CONFIGURATION OF THE DATA STREAMS ON THE GROUND, BOTH REALTIME AND PLAYBACK.
POCC POSSIBLE CONFIG	-0-	102400	THE POCC POSSIBLE CONFIGURATION FILE PROVIDES ALL POSSIBLE POCC CONFIGURATIONS (BOTH REALTIME AND PLAYBACK) AND ALL THE POSSIBLE USER GROUP CONFIGURATIONS FOR ANY GIVEN TIME.
POCC.FIN	61440	12288	LIST OF ALL POCC UNIQUE ACTIVITIES IN SEQUENCIAL ORDER.

```
                             FILE SIZE(BYTES)
INPUT/OUTPUT NAME           MAXIMUM    MINIMUM     INPUT/OUTPUT DESCRIPTION
--------------------------  ---------  ---------   ----------------------------------------
PREL ATT TL                    102400      81920   THIS IS AN ON/OFF FILE CONTAINING THE
                                                   PRELIMINARY ATTITUDE TIMELINE.  THIS IS A
                                                   SUBJECT TYPE 16 ON/OFF FILE.

PREL TDRS AC/LOS              3072000    2867200   THIS IS AN ON/OFF FILE CONTAINING
                                                   PRELIMINARY TDRS ACQUISITION AND LOSS
                                                   TIMES.  THIS IS A SUBJECT TYPE 6 ON/OFF
                                                   FILE.

PRINTOUT OF ECOS TIMELINE   -0-        -0-         PRINTOUT OF THE ECOS TIMELINE TO BE USED
                                                   IN THE ECOS TIMELINE DOCUMENT
                                                   DEVELOPMENT.

PRINTOUTS OF ATMOS PHYSICS  -0-        -0-         PRINTOUT OF ATMOSPHERIC PHYSICS TARGET
DATA                                               OPPORTUNITIES DATA.

PRINTOUTS OF CAND GUIDE     -0-        -0-         THE CANDIDATE GUIDE STAR PRINTOUTS
STARS                                              CONTAIN DATA FOR GUIDE STAR SELECTION
                                                   WHICH INCLUDE: STAR NAME AND NUMBER, STAR
                                                   NO. OF NEXT HIGHER/LOWER RIGHT ASCENSION,
                                                   STAR NO OF NEXT HIGHER/LOWER DECLINATION,
                                                   STAR MAGNITUDE AND MAGNITUDE CORRELATION
                                                   DATA, TIME RANGES WHERE STAR CAN BE USED
                                                   FOR IPS ALIGNMENT, IPS ROLL ANGLES AT
                                                   BEGIN/END OF TIME RANGES.

PRINTOUTS OF CELESTIAL DATA -0-        -0-         PRINTOUT OF CELESTIAL TARGET
                                                   OPPORTUNITIES DATA.

PRINTOUTS OF EARTH OBSERV   -0-        -0-         PRINTOUT OF EARTH OBSERVATION TARGET
DATA                                               OPPORTUNITIES DATA.

PRINTOUTS OF MMU DATA SET   -0-        -0-         PRINTOUTS OF THE MMU DATA SET ARE OUTPUT
                                                   FOR MANUAL VERIFICATION OF THE DATA SET.

-----------------------------------------------------------------------------------------
```

```
                              FILE SIZE(BYTES)
INPUT/OUTPUT NAME            MAXIMUM    MINIMUM     INPUT/OUTPUT DESCRIPTION
--------------------------   ---------  ---------   ----------------------------------------
PRINTOUTS OF MSN IND DATA    -0-        -0-         PRINTOUT OF MISSION INDEPENDENT TARGET
                                                    OPPORTUNITIES DATA.

PRINTOUTS OF PLASMA PHYSICS  -0-        -0-         PRINTOUT OF PLASMA PHYSICS TARGET
DATA                                                OPPORTUNITIES DATA.

PRINTOUTS OF SOLAR DATA      -0-        -0-         PRINTOUT OF SOLAR TARGET OPPORTUNITIES
                                                    DATA.

PRINTOUTS OF STRAY LIGHT     -0-        -0-         PRINTOUTS OF STRAY LIGHT DATA TO BE USED
DATA                                                WHEN SELECTING SOLAR GUIDE STARS.

PROC.                             1000        500   DATABASE OF PCAP PROCEDURES FOR USE IN
                                                    GENERATING PCAP CHARTS.

PROCAM                        10240000    4096000   THIS IS A LIST-DIRECTED FILE CONTAINING
                                                    TIME HISTORIES OF ORBITER ATTITUDES,
                                                    BODY-REFERENCE POINTING DIRECTIONS FOR
                                                    VARIOUS ORBIT-RELATED ITEMS (VELOCITY
                                                    VECTOR, ANGULAR MOMENTUM VECTOR, ETC.),
                                                    CELESTIAL OBJECTS (SUN, MOON) AND TDRS.

PROFILE                      -0-           307200   THE DATA REQUIREMENTS PROFILE FILE
                                                    (PROFILE) CONTAINS A PROFILE OF DATA
                                                    REQUIREMENTS AND POCC RESOURCE USAGE
                                                    BASED ON THE EXPERIMENT TIMELINE AND THE
                                                    DATA FLOW REQUIREMENTS SETS.

-----------------------------------------------------------------------------------------------
```

INPUT/OUTPUT NAME	FILE SIZE(BYTES) MAXIMUM	FILE SIZE(BYTES) MINIMUM	INPUT/OUTPUT DESCRIPTION
PTS CHARTS	-0-	-0-	6-HR PLOTS WITH MET & AMET TICK MARKS EVERY 6 MINUTES. THE CHARTS ARE USED FOR ANALYSIS BY MISSION PLANNING ENGINEERS AND FOR MISSION TIMELINE PUBLICATION. ITEMS ON EACH PLOT PAGE INCLUDE: CREW ACTIVITIES; K-BAND, S-BAND, AND GSTDN COMMUNICATIONS COVERAGE; DATA AND VIDEO DOWNLINKS; DATA AND VIDEO RECORDER DUMPS; WATER DUMP AND THRUSTER INHIBITS; ATTITUDE AND MANEUVER PROFILE; RA & DEC OF ORBITER - Z AXIS FOR INERTIAL ATTITUDES; A MOON PHASE DWG; ORBITER REV NO. AND GROUND TRACK PLOT; SUN/SHADOW PERIODS; AND UNATTENDED (NO CREW) PAYLOAD OPERATIONS. PTS CHARTS ARE PART OF THE PFDF, THE STANDARD POCC DOCUMENTATION FOR SPACELAB MISSIONS, AND ARE INCLUDED IN THE FLIGHT DEFINITION DOCUMENT.
RAD ENVIR	6144000	3072000	THIS IS A LIST-DIRECTED FILE CONTAINING A TIME HISTORY OF THE RADIATION ENVIRONMENT OF A VEHICLE IN ORBIT. PARAMETERS INCLUDE FLUX DATA, B-FIELD DATA, AND MCILWAIN PARAMETERS.
READPI	1024000	512000	THIS IS AN ASCII FILE CONTAINING TARGET DATA AND SUPPORTING DATA USED TO SCHEDULE SCIENCE OBSERVATIONS. TYPES OF DATA INCLUDE TARGET NAME/CLASS/SUBCLASS, REQUESTED VIEWING TIME, CONSTRAINTS DATA, RIGHT ASCENSION AND DECLINATION, TIME GOAL DATA, EARTH SHADOW ACQ/LOSS, AND SAA ACQ/LOSS.

INPUT/OUTPUT NAME	FILE SIZE(BYTES) MAXIMUM	MINIMUM	INPUT/OUTPUT DESCRIPTION
RESERVE PERIODS	204800	61440	THIS IS AN ASCII FILE DEFINING PERIODS OF TIME RESERVED FOR SCIENCE OBSERVATION OR OTHER ACTIVITIES. THE DATA INCLUDES NAME, SCIENCE/NON-SCIENCE, MANEUVER/NO MANEUVER, ON TIME, OFF TIME, CLASS, REQUESTED TIME, RIGHT ASCENSION, AND DECLINATION.
SAA AC/LOS	61440	30720	THIS IS AN ON/OFF FILE CONTAINING SOUTH ATLANTIC ANOMALY (SAA) ACQUISITION AND LOSS TIMES. THIS IS A SUBJECT TYPE 0 ON/OFF FILE.
SCIENCE SCHED'LE	819200	409600	THIS IS AN ON/OFF FILE CONTAINING ON/OFF TIMES OF THE OBSERVATION PERIODS FOR EACH TARGET (SUBJECT). THIS IS A SUBJECT TYPE 3 ON/OFF FILE.
SITE AC/LOS	1024000	512000	THIS IS AN ON/OFF FILE CONTAINING EARTH GROUND SITE ACQUISITION AND LOSS TIMES. THIS IS A SUBJECT TYPE 0 ON/OFF FILE.
SITE DEF.	409600	204800	THIS IS A NAME-DIRECTED FILE CONTAINING AN ARRAY DEFINING GROUND SITE POLYGONS. THE ARRAY CONTAINS THE SITE NAME, NUMBER OF SIDES (VERTICES) FOR EACH SITE, AND GEODETIC LATITUDE AND LONGITUDE OF EACH VERTEX.

```
                               FILE SIZE(BYTES)
INPUT/OUTPUT NAME            MAXIMUM     MINIMUM    INPUT/OUTPUT DESCRIPTION
--------------------------  ----------  ----------  ----------------------------------
SKYMAP DATBSE                   819200      409600  THE SOURCE OF THE STARS FOR DEVELOPING
                                                    THE SKYMAP DATABASE IS THE "SKYMAP STAR
                                                    CATALOG" PREPARED FOR GSFC BY CSC IN
                                                    DECEMBER, 1977.  VERSION III OF THIS
                                                    CATALOG CONTAINS 248727 STARS EQUAL OR
                                                    GREATER IN BRIGHTNESS THAN 9TH MAGNITUDE.
                                                    THE STAR POSITIONS ARE GIVEN IN TERMS OF
                                                    RIGHT ASCENSION AND DECLINATION WITH
                                                    RESPECT TO EPOCH 2000.  THERE ARE 135
                                                    DISCRIPTIVE OR QUALIFYING WORDS OF DATA
                                                    FOR EACH STAR IN THE CATALOG.  THESE ARE
                                                    REDUCED TO 34 WORDS IN THE SKYMAP
                                                    DATABASE.

SOLAR CONSTS                    102400       40960  THIS IS AN ON/OFF FILE CONTAINING ON/OFF
                                                    TIMES WHICH REPRESENT TIME PERIODS WHERE
                                                    CERTAIN SOLAR REQUIREMENTS/CONSTRAINTS
                                                    HAVE BEEN SATISFIED.  THIS IS A SUBJECT
                                                    TYPE 0 ON/OFF FILE.

SOLAR TARGETS                   204800      102400  THIS IS AN ON/OFF FILE CONTAINING SOLAR
                                                    TARGETS AFTER REQUIREMENTS/CONSTRAINTS
                                                    HAVE BEEN COMBINED (BY UNION,
                                                    INTERSECTION, OR COMPLEMENT).  THIS IS A
                                                    SUBJECT TYPE 0 ON/OFF FILE.

STATE VECTOR ELECTRONIC           1618        1618  ELECTRONIC TRANSFER OF STATE VECTOR
                                                    CONTAINING A COORDINATE SYSTEM
                                                    DEFINITION, TIME (GMT), VECTOR POSITION
                                                    (M), AND VECTOR VELOCITY (M/S).

------------------------------------------------------------------------------------------
```

INPUT/OUTPUT NAME	FILE SIZE(BYTES) MAXIMUM	FILE SIZE(BYTES) MINIMUM	INPUT/OUTPUT DESCRIPTION
STATE VECTOR PRINTOUT	0	0	PRINTOUT CONTAINS THE FOLLOWING ORBIT PARAMETERS: RADIUS (M), VELOCITY (M/S), FLIGHT PATH ANGLE (DEG), GEOCENTRIC LATITUDE (DEG), LONGITUDE (DEG), INERTIAL AZIMUTH (DEG), AND ORBIT INSERTION TIME (MET-HRS).
STL PRINTOUTS	-0-	-0-	PRINTOUTS OF THE ECOS SUBORDINATE TIMELINES.
SUB TL	400	388	SUBORDINTE TIMELINE EVENTS. DELTA TIMES FOR EACH EVENT.
SUBCOO	409600	122880	THE SUBCOO FILE IS AN ASCII FILE CONTAINING A SUBSET OF THE CELESTIAL OBJECTS CONTAINED IN THE COO FILE. THE DATA TYPES ARE THE SAME AS THOSE CONTAINED IN THE COO FILE.
SUN AZ/ELV	409600	102400	THIS IS A LIST-DIRECTED FILE CONTAINING A TIME HISTORY OF THE FOLLOWING DATA: TIME (GMT AND MET), AZIMUTH AND ELEVATIONS OF THE SUN IN THE ATMOS EXPERIMENT COORDINATE SYSTEM, TANGENT RAY HEIGHT, SUN AZIMUTH AND CO-ELEVATION IN THE ORBITER COORINATE SYSTEM, ALTITUDE, SUN RIGHT ASCENSION AND DECLINATION.
SUN RISE/SET	40960	30720	THIS IS AN ON/OFF FILE CONTAINING SUN RISE AND SET TIMES. THIS IS A SUBJECT TYPE O ON/OFF FILE.

```
                              COMPUTER INPUT/OUTPUT SUMMARY              DATE 03/18/87

                                                                         PAGE        23

                             FILE SIZE(BYTES)
INPUT/OUTPUT NAME            MAXIMUM      MINIMUM      INPUT/OUTPUT DESCRIPTION
---------------------------  ----------   ----------   ------------------------------------------
TABULAR REPORTS              -0-          -0-          TABULAR REPORTS AND PLOTS TO BE INCLUDED
                                                       IN DATA FLOW AND DATA SYSTEMS
                                                       DOCUMENTATION.

TAMRAY EPHEM                    409600       102400    THIS IS A LIST-DIRECTED FILE CONTAINING A
                                                       TIME HISTORY OF ORBITAL ELEMENT
                                                       PARENETERS, SUN RISE AND SET EVENTS, AND
                                                       DATA RELATIVE TO THE TANGENT POINT ON THE
                                                       ORBITER TO SUN LINE-OF-SIGHT.

TARGET ANALYSIS PRINTOUT     -0-          -0-          TARGET ANALYSIS STATISTICAL AND GROUPING
                                                       DATA THAT AIDS IN BLOCKING OUT EXPERIMENT
                                                       OPERATION TIMES AND OVERALL SCHEDULING.

TDRS AC/LOS                     614400       409600    THIS IS AN ON/OFF FILE CONTAINING TDRS
                                                       ACQUISITION AND LOSS TIMES.  THIS IS A
                                                       SUBJECT TYPE 6 ON/OFF FILE.

TERM AC/LOS                     204800       102400    THIS IS AN ON/OFF FILE CONTAINING THE
                                                       TIMES OF THE ORBIT TERMINATORS.  THE "ON"
                                                       TIME BEING THE TIME OF DAYLIGHT TO
                                                       DARKNESS TRANSITION AND THE "OFF" TIME
                                                       BEING THE TIME OF DARKNESS TO DAYLIGHT
                                                       TRANSITION.  THIS IS A SUBJECT TYPE 0
                                                       ON/OFF FILE.

TIME GOAL                        12288         6144    THIS IS AN ASCII FILE DEVELOPED BY THE PI
                                                       DEFINING THE CLASS OF THE OBJECT(S) TO BE
                                                       VIEWED, THE TIME TO BE SCHEDULED DURING
                                                       THE DAY, AND THE TIME TO BE SCHEDULED AT
                                                       NIGHT.

-------------------------------------------------------------------------------------------------
```

```
                                   COMPUTER INPUT/OUTPUT SUMMARY          DATE 03/18/87

                                                                          PAGE        24

                                  FILE SIZE(BYTES)
INPUT/OUTPUT NAME               MAXIMUM     MINIMUM     INPUT/OUTPUT DESCRIPTION
-----------------------------   ----------  ----------  ----------------------------------------
VERIFY ERROR                    -0-              20480  THE VERIFY ERROR FILE LIST ALL ERRORS
                                                        ENCOUNTERED BY THE DATA VERIFICATION
                                                        MODULE WHEN COMPARING THE SCHEDULES ON
                                                        THE MASTER FILE TO OTHER DEFINITION
                                                        AND/OR SCHEDULE FILES.

-0-                             -0-         -0-         -0-
------------------------------------------------------------------------------------------------
```

TABLE 8
MANUAL INPUT/OUTPUT SUMMARY

```
                              MANUAL INPUT OUTPUT SUMMARY DATA                    DATE 03/18/87

                                                                                  PAGE        1

INPUT/OUTPUT NAME                 TYPE              DOCUMENT INCLUDED IN   INPUT/OUTPUT DESCRIPTION
--------------------------------  ----------------  ------------------     --------------------------------------------------
ATMOS DESIRED VEHICLE ATTITUDE    VERBAL, WRITTEN   N/A                    THE DESIRED VEHICLE ATTITUDE FOR THE ATMOS
                                                                           EXPERIMENT IS DEFINE BY TIME, REFERENCE
                                                                           COORDINATE SYSTEM, PITCH, YAW, AND ROLL.

ATTITUDE UPDATES                  VERBAL, WRITTEN   N/A                    ATTITUDE UPDATES BASED ON ATTITUDE/TDRS ITERATION
                                                                           AND REVIEW CYCLE COMMENTS/INPUTS.

BASIC CO-ORBITING REQUIREMENTS    VERBAL, WRITTEN   EFORD                  A DETERMINATION OF THE TYPES OF ORBIT OPERATIONS
                                                                           THAT ARE REQUIRED:  PROXIMITY OPERATIONS,
                                                                           DEPLOYMENT, RENDEZVOUS, GRAPPLE/CAPTURE.

BASIC CREW CYCLE                  VERBAL/INFORMAL   N/A                    BASIC SLEEP/ WORK CYCLES OBTAINED FROM JSC.
                                  DOCUMENT

BORB CONSTRAINTS                  VERBAL, WRITTEN   N/A                    CONSTRAINTS TO CONSIDER WHEN DEVELOPING PLASMA
                                                                           PHYSICS TARGET OPPORTUNITIES INCLUDE: B AZ, B
                                                                           ELEV, B DOT X, L SHELL (TYPICAL).

CDMS DICTIONARY                   DOCUMENT          N/A                    COMMAND AND DATA MANAGEMENT SYSTEM DICTIONARY
                                                                           (PFDF DOCUMENT). CONTAINS DISPLAY DEFINITIONS.

CDMS SYSTEM DEFINITION            DOCUMENTS         N/A                    COLLECTION OF DOCUMENTS THAT DESCRIBE THE CDMS
                                                                           FOR THE FLIGHT IN QUESTION (SPAN,ICD'S,ETC.).

CEL TARGET(S) ELEV ANGLE CONSTS   VERBAL, WRITTEN   N/A                    ELEVATION ANGLE CONSTRAINTS RELATIVE TO CELESTIAL
                                                                           OBJECT(S) VIEWING PERIODS.

CELESTIAL TARGETS                 VERBAL, WRITTEN   N/A                    CELESTIAL TARGET DATA (NUMBER, NAME, RIGHT
                                                                           ASCENSION, AND DECLINATION) ARE INPUT MANUALLY
                                                                           USING THE STAR PROGRAM TO CREATE A CANDIDATE
                                                                           CELESTIAL TARGET FILE.

COMMANDS FROM PI                  INFORMAL          N/A                    CHRONOLOGICAL LISTING OF ALL COMMANDS TO THE PI'S
                                  DOCUMENTS                                EXPERIMENT.

---------------------------------------------------------------------------------------------------------------------------
```

MANUAL INPUT OUTPUT SUMMARY DATA

INPUT/OUTPUT NAME	TYPE	DOCUMENT INCLUDED IN	INPUT/OUTPUT DESCRIPTION
COOLING LOAD REQMTS	INFORMAL DOCUMENT	N/A	HEAT REJECTION PROFILES FOR THE INTEGRATED PAYLOAD.
CREW W/O CYCLE	VERBAL, WITTEN	N/A	CREW W/O TIMES, DURATIONS
CREW PROCEDURES DOCUMENT	DOCUMENT	PFDF	PFDF DOCUMENT GIVING A COMPLETE DESCRIPTION OF ALL PAYLOAD CREW PROCEDURES.
CREW SHIFT TIMES	VERBAL/INFORMAL DOCUMENT	N/A	CREW SHIFT TIMES. COMES OUT OF BASIC CREW CYCLE INPUT FROM JSC.
DATA FLOW ANALYSIS FDD INPUTS	VERBAL, WRITTEN	FDD	DATA FLOW ANALYSIS INPUTS TO THE FLIGHT DEFINITION DOCUMENT.
EARTH OBSERV SUN ELEV CONSTS	VERBAL, WRITTEN	N/A	SUN ELEVATION ANGLE CONSTRAINTS RELATIVE TO EARTH OBSERVATION PERIODS.
ECOS T/L PRINTOUTS	PRINTOUT	N/A	CONTENTS OF ALL ECOS MASTER AND SUBORDINATE TIMELINES
ECOS TIMELINE DOCUMENT	DOCUMENT	ECOS TIMELINE DOCUMENT	CONTENTS OF ALL ECOS MASTER AND SUBORDINATE TIMELINES PLUS SOME BOILERPLATE PAGES
ERD'S	DOCUMENT	EXPERIMENT REQUIREMENTS DOCUMENT	FUNCTIONAL OBJECTIVES (FO'S), EQUIPMENT IDENTIFICATION, OPERATIONAL FUNCTIONAL FLOW, STRUCTURAL/MECHANICAL, POINTING & STABILITY PARAMETERS, ALIGNMENT/CO-ALIGNMENT, ORBITAL REQUIREMENTS AND CONSTRAINTS, ELECTRIAL REQUIREMENTS, THERMAL CONTROL/ FUILD REQUIREMENTS, DATA SYSTEM REQUIREMENTS DOCUMENT, FLIGHT SW - SUMMARY OF EXP. COMPUTER SW REQMTS, PHYSICAL CONFIGURATION, MISSION OPERATIONS SUPPORT, POCC REQMTS, SL DATA PROCESSING FACILITY (SLDPF), OTHER DATA PRODUCTS.

```
                                                                                   DATE 03/18/87
                                   MANUAL INPUT OUTPUT SUMMARY DATA
                                                                                   PAGE        3

                                                          DOCUMENT INCLUDED IN   INPUT/OUTPUT DESCRIPTION
INPUT/OUTPUT NAME                   TYPE                                         ------------------------------------------------
----------------------------------  ------------------   --------------------
ESS MODELS PRINTOUT                 PRINTOUT              N/A                    PRINTOUT OF THE ESS MODEL FILE.

ESS TARGET PRINTOUTS                PRINTOUT              N/A                    PRINTOUT OF THE ESS TARGET FILE.

EXP T/L PRINTOUTS                   PRINTOUT              N/A                    PRINTOUT OF THE EXPERIMENT TIMELINE FILE.

FLIGHT DEFINITION DOCUMENT          DOCUMENT              FLIGHT DEFINITION      SUMMARY - MISSION OVERVIEW, LAUNCH WINDOW, ORBIT
                                                          DOCUMENT               DEFN, ATTITUDE DATA, PAYLOAD ON-ORBIT ACTIVITES,
                                                                                 PAYLOAD TIMELINE SUMMARY (PTS CHARTS), ORBITER
                                                                                 CREW PAYLOAD SUPPORT REQMTS, CONTAMINATION
                                                                                 AVOIDANCE REQMTS, RESOURCE UTILIZATION, CREW TIME
                                                                                 USAGE, ELECTRICAL POWER & ENGERGY USAGE, ECOS
                                                                                 USAGE, ECAS USAGE;  ORBITAL MECHANICS AREA -
                                                                                 NOMINAL FLIGHT PROFILE, LAUNCH DATE/TIME, ORBIT
                                                                                 DATA REV BY REV, GROUND TRACKS & ORBITAL LIGHTING
                                                                                 DATA, COMMUNICATIONS OPPORTUNITIES, CONSTRAINTS,
                                                                                 K-BAND, S-BAND & GROUND COVERAGE.  DETAILED T/L
                                                                                 DATA; APP B - COMPOSITE T/L TABLES, INDIVIDUAL
                                                                                 EXP T/L TABLES, CREW & SYSTEM T/L TABLE.

                                                                                 FUNCTIONAL OBJECTIVES DEFINITION, RESOURCE AND
FO'S                                WRITTEN               ERD'S, FO INPUT        TIME REQMTS, STEP REQMTS, ETC..
                                                          SHEETS

                                                          FLIGHT PLANNING        LAUNCH WINDOW DATA, ORBITAL PARAMETERS DATA,
FPA INPUTS                          DOCUMENT              ANNEX                  PAYLOAD ELECTRICAL POWER REQMTS - TOTAL SUBSYSTEM
                                                                                 PAYLOAD OWER CHARTS/TABLES, RESISTIVE VS CONSTANT
                                                                                 POWER USAGE, ESSENTIAL PWR REQMTS, COOLING LOAD
                                                                                 REQUIREMENTS, ORITER EQUIPMENT USAGE, FLIGHT
                                                                                 ACTIVITY REQUIREMENTS, CREW ACTIVITY
                                                                                 REQUIREMENTS, MODEL SUMMARY, PCAP TAPE, ORBITER
                                                                                 CREW PAYLOAD SUPPORT, ATTITUDE DATA, EXP.
                                                                                 POINTING REQMTS, OBJECT AVOIDANCE DATA,
                                                                                 CONTAMINATION AVOIDANCE, PHOTO REQMTS, TV
                                                                                 REQUIREMENTS, TV SCIENCE DATA/SPONSOR, VCR
                                                                                 REQUIREMENTS.
-------------------------------------------------------------------------------------------------------------------------------
```

INPUT/OUTPUT NAME	TYPE	DOCUMENT INCLUDED IN	INPUT/OUTPUT DESCRIPTION
GROUND SITE POLYGONS	VERBAL, WRITTEN	N/A	GROUND SITE POLYGONS ARE DEFINED BY NAME OF SITE, NUMBER OF SIDES (VERTICES) FOR EACH SITE, AND GEODETIC LATITUDE AND LONGITUDE FOR EACH VERTEX.
GUIDE STAR CHOICES	VERBAL, WRITTEN	N/A	A LIST OF GUIDE STARS TO BE USED FOR SOLAR OBJECTIVE LOAD GENERATION. THE LIST IS BY NAME AND NUMBER.
HDRR DUMP TIMES	VERBAL, WRITTEN	N/A	HDRR DUMP TIMES FROM THE ONBOARD RECORDER PLAYBACK SCHEDULE.
INPUTS FROM PI'S	VERBAL, WRITTEN	N/A	INPUTS FROM EXPERIMENT PI'S RELATIVE TO ECOS TIMELINES (STL'S,MTL'S).
INPUTS TO MISSION PLANNING	VERBAL, WRITTEN	N/A	DATA PROVIDED FOR MISSION PLANNING PERSONNEL RELATIVE TO CO-ORBITING TARGETS REQMTS/CONSTRAINTS TO BE USED IN DEVELOPING MISSION PROFILE AND EXPERIMENT OPERATION: BLOCK OUT OPERATIONAL TIME PERIODS, PROVIDE TARGET PERIODS FOR FO'S, IDENTIFY MAJOR EVENTS, PROVIDE A MANEUVER OR ATTITUDE TIMELINE.
INPUTS/UPDATES TO IPRD	VERBAL, WRITTEN	IPRD	INITIAL INPUTS OR UPDATES MADE TO THE IPRD AS A RESULT OF THE PAYLOAD DATA COLLECTION EFFORT AND ASSOCIATED ANALYSES.
INPUTS/UPDATES TO O&IA	VERBAL, WRITTEN	O&IA	INITIAL INPUTS OR UPDATES MADE TO THE O&IA AS A RESULT OF THE PAYLOAD DATA COLLECTION EFFORT AND ASSOCIATED ANALYSES.

INPUT/OUTPUT NAME	TYPE	DOCUMENT INCLUDED IN	INPUT/OUTPUT DESCRIPTION
IPRD DOCUMENT	DOCUMENT	N/A	INTEGRATED PYLDS RQMTS DOCUMENT DEFINING: CONFIGURATION; MASS PROPERTIES; STRUCTURAL MECHANICL REQU'S; ELECTRICAL POWER AND ENERGY; THERMAL/ENVIRONMENTAL CONTROL; ON-ORBIT VEHICLE DYNAMICS; POINTING & ALIGNMENT; CDMS; SOFTWARE; CREW SYSTEMS; STOWAGE; GROUND OPS; FLIGHT OPS; MISSION UNIQUE ENVIRONMENTS.
LATITUDE CONSTRAINTS	VERBAL, WRITTEN	N/A	LATITUDE CONSTRAINTS APPLIED TO HEMISPHERE OPPORTUNITIES SELECTION RELATIVE TO PLASMA PHYSICS TARGET OBSERVATION PERIODS.
LAUNCH WINDOW/LAUNCH TIME DATA	VERBAL, WRITTEN	N/A	LAUNCH WINDOWN OPENNING AND CLOSING (GMT), AND TIME OF LAUNCH (GMT)
MGMT AGREEMENT ON GROSS MSN T/L	VERBAL, WRITTEN	N/A	DATA PROVIDING AN AGREEMENT ON THE GROSS MISSION TIMELINE TO BE USED FOR THE MISSION. MISSION PLANNING ITERATIONS TO EXPAND AND/OR REFINE THIS TIMELINE ARE EXPECTED IN ORDER TO RESOLVE PROBLEMS OR CONFLICTS DISCOVERED DURING MORE DETAIL PLANNING ACTIVITIES.
MISSION CONFIGURATION	VERBAL/WRITTEN/DOCUMENT	SPAN	LAUNCH TIME, MISSION DURATION, CREW DATA, AND THE TYPES OF RESOURCES AND EQUIPMENT TO BE USED DURING THE MISSION ALONG WITH THEIR AVAILABILITIES.
MISSION PROFILE CONSIDERATIONS	VERBAL, WRITTEN	N/A	CONSIDERATIONS IN DEVELOPING A GROSS MISSION TIMELINE INCLUDE: EXP. PRIORITIES, DIFFICULTY IN SCHEDULING EXP. OPERATIONS, SYSTEMS REQMTS, CREW W/O CYCLE, DATA MANAGEMENT, AND MANAGEMENT DIRECTIONS.
MISSION T/L ANALYSIS FDD INPUTS	VERBAL, WRITTEN	FDD	MISSION TIMELINE ANALYSIS INPUTS TO THE FLIGHT DEFINITION DOCUMENT..

INPUT/OUTPUT NAME	TYPE	DOCUMENT INCLUDED IN	INPUT/OUTPUT DESCRIPTION
MISSION T/L ANALYSIS FPA INPUTS	VERBAL, WRITTEN	FPA	MISSION TIMELINE ANALYSIS INPUTS TO THE FLIGHT PLANNING ANNEX.
MISSION TL TABLES, PRINTOUTS	TABLES, PRINTOUT	N/A	DETAILED TABULATIONS, PLOTS AND PRINTOUT OF THE MISSION TIMELINE.
MODIFICATIONS	VERBAL, WRITTEN	N/A	MODIFICATIONS MADE TO DATA FLOW SCHEDULES BASED ON REVIEW AND USER EXPERIENCE.
MPE OPS REQMTS	DOCUMENT	ICD	MISSION PECULIAR EQUIPMENT OPERATIONAL REQUIREMENTS.
MSN EXP OPPORTUNITIES DATA	VERBAL, WRITTEN	N/A	THIS DATA INCLUDES PRINTOUTS AND/OR PLOTS GENERATED BY THE EXPERIMENT OPPORTUNITIES GENERATION SUBFUNCTION. THESE DATA REPRESENT EXPERIMENT OPERATION PERIODS WHERE REQUIREMENTS AND/OR CONSTRAINTS HAVE BEEN SATISFIED. THESE DATA INCLUDE: MISSION INDEPENDENT, CELESTIAL, ATMOSPHERIC PHYSICS, SOLAR, EARTH OBSERVATION, PLASMA PHYSICS, AND CO-ORBITING TARGET OPPORTUNITIES DATA.
MSN SUPPORT PERSONNEL/POH IPUTS	VERBAL,WRITTEN	POCC CHECKLIST	INPUTS TO THE POCC CHECKLIST FROM MISSION SUPPORT PERSONNEL AND EXTRACTED FROM THE POCC OPERATIONS HANDBOOK.

INPUT/OUTPUT NAME	TYPE	DOCUMENT INCLUDED IN	INPUT/OUTPUT DESCRIPTION
O&IA	DOCUMENT	O&IA DOCUMENT	FUNCTIONAL DESCRIPTION; PAYLOAD ELEMENT H/W DESCRIPTION, INSTRUMENT OPERATING MODES, DELIVERABLE ITEMS LIST, SHIPPING INSTRUCTIONS. FLIGHT OPS SUPPORT; FUNCTIONAL OBJECTIVES, POCC SERVICES & DATA PRODUCT REQUIREMENTS, ORBITAL REQMTS & CONSTRAINTS, TRAINING REQMTS. PHYSICAL INTEGRATION; ACTIVITY FLOW, KSC SUPPORT REQUIREMENTS, ON-LINE ACTIVITY REQMTS, PERSONNEL SUPPORT REQMTS, LAUNCH DELAY CONTINGENCY PLANNING, ALTERNATE LANDING SITE CONTINGENCY PLANNING. PROCEDURES INPUTS; KSC PROCEDURES, ON-BOARD FLIGHT PROCEDURES, POCC PROCEDURES, APP A - SPACELAB CDMS REQUIREMENTS FORMS & DATA FORMATS; APP B - MISSION T/L FUNCTIONAL OBJECTIVE REQMTS SHEETS.
ORBIT ANALYSIS FDD INPUTS	VERBAL,WRITTEN	FDD	ORBIT ANALYSIS INPUTS TO THE FLIGHT DEFINITION DOCUMENT.
ORBIT ANALYSIS FPA INPUTS	VERBAL,WRITTEN	FPA	ORBIT ANALYSIS INPUTS TO THE FLIGHT PLANNING ANNEX.
ORBIT DEFINITION PARAMETERS	VERBAL, WRITTEN	N/A	ORBIT ATTITUDE (KM) AND ORBIT INCLINATION (DEG)
OTHER PI INPUTS	VERBAL,WRITTEN	N/A	INPUTS MADE BY THE PI'S TO BE INCORPORATED INTO THE PAYLOAD FLIGHT DATA FILE.
PAO REQMTS	VERBAL/INFORMAL DOCUMENT	N/A	PUBLIC AFFAIRS OFFICE REQUIREMENTS PERTAINING TO TV PHOTOACTIVITY OF SELECTED EXPERIMENT ACTIVITY.
PAYLOAD COMPLEMENT DEFINITION	VERBAL, WRITTEN	FDD	DATA DEFINING THE EXPERIMENTS TO BE FLOWN ON THE MISSION.
PAYLOAD SYSTEMS HANDBOOK	DOCUMENT	PFDF	PFDF DOCUMENT CONTAINING CREW PROCEDURES SPECIFIC TO OVERALL PAYLOAD SYSTEMS.

INPUT/OUTPUT NAME	TYPE	DOCUMENT INCLUDED IN	INPUT/OUTPUT DESCRIPTION
PCAP CHARTS	CHARTS	PCAP	DETAILED 1-HR CHARTS PRODUCED ON A HIGH RESOLTUION LASER PRINTER WHICH BECONE PART OF THE PFDF. THE PLAN SHOWS THE PROCEDURES THE CREW EXECUTES AND ASSOCIATED NOTES. IT ALSO SHOWS AUXILIARY INFORMATION SUCH AS ORBIT ATTITUDE AND MANEUVERS, SUN/SHADOW, K-AND S-BAND COMMUNICATIONS,NRM FORMAT, RECORDER USAGE, ORBIT REVOLUTION NUMBERS AND OTHER DATA.
PCAP DOCUMENT	DOCUMENT	PAYLOAD CREW ACTIVITY PLAN	BOUND TABBED DOCUMENT CONTAINING THE PAYLOAD CREW ACTIVITY PLAN (PCAP) CHARTS AND THE PAYLOAD TIMING SUMMARY (PTS) CHARTS, INCLUDED IN THE PAYLOAD FLIGHT DATA FILE TO ASSIST THE CREW IN ON-BOARD PAYLOAD OPERATIONS.
PFDF DOCUMENTS	DOCUMENT	PFDF	PAYLOAD FLIGHT DATA FILE DOCUMENTS.
PI INTERFACE	VERBAL, WRITTEN	N/A	DISCUSSIONS WITH PI'S TO OBTAIN EXPERIMENT REQUIRMENTS AND CONSTRAINTS, CLARIFICATION OF INPUTS, AND COORDINATION OF UPDATES.
PI ORBIT TERM REQNTS	VERBAL, WRITTEN	N/A	PI REQNTS/CONSTRAINTS TO CONSIDER WHEN SELECTING ORBIT TERMINATOR TARGETS AS RELATED TO ATMOSPHERIC PHYSICS OBSERVATION PERIODS.
PI REQUIREMENTS/CONSTRAINTS	VERBAL, WRITTEN	N/A	EVALUATION AND DEVELOPMENT OF PI CO-ORBITING REQUIREMENTS/CONSTRAINTS FOR INPUT: INSTRUMENT REQUIREMENTS, LIGHTING REQUIREMENTS, LINE-OF-SIGHT POINTING, DATA/COMMUNIATION REQUIREMENTS.
PL PHYSICS DESIRED VEH. ATTITUDE	VERBAL, WRITTEN	N/A	THE DESIRED VEHICLE ATTITUDE WHEN COMPUTING ORIENTATION AND STRENGTH OF THE MAGNETIC FIELD FOR PLASMA TARGETS.

INPUT/OUTPUT NAME	TYPE	DOCUMENT INCLUDED IN	INPUT/OUTPUT DESCRIPTION
PL/EXP CONSTRAINTS	VERBAL, WRITTEN	ERD'S, O&IA	TYPICAL PAYLOAD/EXPERIMENT CONSTRAINTS TO CONSIDER WHEN DETERMINING LAUNCH WINDOW AND LAUNCH TIME INCLUDE: BETA ANGLE, COMM COINSIDERATIONS, SUN OR MOON CONSTRAINTS, ORBIT OR EARTH DARKNESS, TARGET VIEWING, PAYLOAD DEPLOYMENT
PRELIM MMU MAP	INFORMAL DOCUMENT	N/A	NAMES OF ALL FILES ON MMU
PRINTOUT OF ECOS TIMELINE	PRINTOUT	N/A	PRINTOUT OF THE ECOS TIMELINE TO BE USED IN THE ECOS TIMELINE DOCUMENT DEVELOPMENT.
PRINTOUTS OF CAND GUIDE STARS	PRINTOUT	N/A	THE CANDIDATE GUIDE STAR PRINTOUTS CONTAIN DATA FOR GUIDE STAR SELECTION WHICH INCLUDE: STAR NAME AND NUMBER, STAR NO. OF NEXT HIGHER/LOWER RIGHT ASCENSION, STAR NO. OF THE NEXT HIGHER/LOWER DECLINATION, STAR MAGNITUDE AND MAGNITUDE CORRELATION DATA, TIME RANGES WHERE STAR CAN BE USED FOR IPS AGLINMENT, IPS ROLL ANGLES AT BEGINNING/END OF TIME RANGES.
PRINTOUTS OF STRAY LIGHT DATA	PRINTOUT	N/A	PRINTOUT OF STRAY LIGHT DATA TO BE USED WHEN SELECTING SOLAR GUIDE STARS.

INPUT/OUTPUT NAME	TYPE	DOCUMENT INCLUDED IN	INPUT/OUTPUT DESCRIPTION
PTS CHARTS	CHARTS	PCAP	6-HOUR PLOTS WITH MET & AMET TICK MARKS EVERY 6 MINUTES. THE CHARTS ARE USED FOR ANALYSIS BY MISSION PLANNING ENGINEERS AND FOR MISSION TIMELINE PUBLICATION. ITEMS ON EACH PLOT PAGE INCLUDE CREW ACTIVITIES; S-BAND, K-BAND, AND GSTON COMMUNICATION COVERAGES; DATA & VIDEO DOWNLINKS; DATA & VIDEO RECORDER DUMPS; WATER DUMP & THRUSTER FIRE INHIBTS; ATTITUTDE & MANEUVER PROFILE; RADEC OF ORBITER - Z AXIS FOR INERTIAL ATTITUDES; A MOON PHASE DWG; ORBITER REVOLUTION #'S AND A GROUND TRACK PLOT; SUN/SHADOW PERIODS; AND UNATTENDED (NO CREW) PAYLOAD OPERATIONS. PTS CHARTS ARE PART OF THE PFDF AND THE STANDARD POCC DOCUMENTATION FOR SPACELAB MISSION, AND ARE INCLUDED IN THE FLIGHT DEFINITION DOCUMENT.
RADIATION CONSTRAINTS	VERBAL, WRITTEN	N/A	RADIATION ENVIRONMENT CONSTRAINTS RELATIVE TO EXPERIMENT OPERTAIONS (MEV, FLUX, PARTICLE/C2) WHEN DEFINING THE SOUTH ATLANTIC ANOMALY PERIODS.
RESERVE PERIOD CONSIDERATIONS	VERBAL, WRITTEN	N/A	THE FACTORS TO CONSIDER WHEN DEVELOPING A RESERVE PERIOD FILE ARE: 1) TIME FOR TARGET, 2) CREW N/O CYCLES, 3) SYSTEMS REQUIRMENTS, 4) PAO ACTIVITIES, 5) MOVING TARGETS.
REVIEW CYCLE UPDATES	VERBAL, WRITTEN	N/A	UPDATES MADE TO THE MISSION TIMELINE AS A RESULT OF ATTITUDE/TDRS ITERATIONS, DIVISION MANAGEMENT REVIEWS, JSC REVIEWS, AND ECOS MISSION TIMELINE PERSONNEL REVIEWS.
SHIFT TIMES	VERBAL, WRITTEN	N/A	CREW SHIFT TIMES.
SL/PL INTERFACE DEFINITION	DOCUMENT	ICD-B	DEFINITION OF THE OPERATIONAL INTERFACES BETWEEN SL SYSTEMS AND P/L SYSTEMS.

INPUT/OUTPUT NAME	TYPE	DOCUMENT INCLUDED IN	INPUT/OUTPUT DESCRIPTION
SOPG TIMES	VERBAL/INFORMAL DOCUMENT	N/A	TIMES THAT THE SCIENCE OPERATIONS PLANNING GROUP IS TO MEET DURING THE MISSION.
SPAH AND SL SYSTEM DOCUMENTATION	DOCUMENT	SPAH	SL CONFIGURATION, OPERATION AND ALLOCATIONS
SPECIAL CHECKS	VERBAL, WRITTEN	N/A	SPECIAL CHECKS OF DATA FLOW SCHEDULES IN THE PROCESS OF VERIFICATION.
SPECIAL CREW NOTES	VERBAL	N/A	SPECIAL NOTES REQUIRED BY THE CREW FOR INPUT INTO THE PCAP NOTES COLUMN.
SPECIAL TARGET	INFORMAL	N/A	TARGETS (EXPERIMENT OPPORTUNITIES), WHICH BECAUSE OF EITHER THE TIMING OF THEIR IDENTIFICATION OR THEIR NATURE ALLOWS THEM TO BE BUILT MORE EFFICIENTLY IN THE CREATE ESS TARGET FILE SUBFUNCITON RATHER THAN THE EXPERIMENT OPPORTUNITIES GENERATION SUBFUNCTION.
SPECIAL TIMELINE NOTES	INFORMAL PAPER	N/A	SPECIAL NOTES FROM TIMELINE ANALYSIS ENGINEERS REQUIRED TO BE INPUT IN THE PCAP NOTES COLUMN.
STATE VECTOR FROM JSC	VERBAL, WRITTEN	N/A	STATE VECTOR DEFINITION AS FOLLOWS: RADIUS (NMI) VELOCITY (FT/SEC), FLIGHT PATH ANGLE (DEG), GEOCENTRIC LATITUDE (DEG), LONGITUDE (DEG), INERTIAL AZIMUTH (DEG), AND TIME (MET-HRS).
STATE VECTOR PRINTOUT	PRINTOUT	N/A	PRINTOUT PROVIDES THE STATE VECTOR DEFINITION AS FOLLOWS: RADIUS (KM), VELOCITY (KM/SEC), FLIGHT PATH ANGLE (DEG), GEOCENTRIC LATITUDE (DEG), LONGITUDE (DEG) INERTIAL AZIMUTH (DEG), AND ORBIT INSERTION TIME (MET-HRS.)
STL PRINTOUTS	PRINTOUT	N/A	PRINTOUT OF THE ECOS SUBORDINATE TIMELINES.

INPUT/OUTPUT NAME	TYPE	DOCUMENT INCLUDED IN	INPUT/OUTPUT DESCRIPTION
STOWAGE BOOK	DOCUMENT	PFDF	THE STOWAGE BOOK CONTAINS A LIST OF ALL EQUIPMENT STORED ONBOARD AND IT'S LOCATION.
STS CAPABILITIES DOCUMENTATION	DOCUMENTS	N/A	DOCUMENTATION DESCRIBING STS CAPABILITIES AND STS/PAYLOAD/INTERFACES IN DETAIL (SPAN,ICD-A).
STS CONSTAINTS	VERBAL, WRITTEN	STS DOCUMENTATION	TYPICAL STS CONSTRAINTS TO CONSIDER WHEN DETERMINING LAUNCH WINDOW AND LAUNCH TIME INCLUDE: LANDING SITE (NOMINAL AND ABORT), LIGHTING AT LAUNCH, LIGHTING AT LANDING, LAUNCH CAPABILITIES, COMM CONSTRAINTS.
STS REQMTS/CONSTRAINTS	VERBAL, WRITTEN	N/A	EVALUATION AND DEVELOPMENT OF STS CONSTRAINTS AS RELATED TO CO-ORBITING OPERATIONS FOR INPUTS: STS OPERATIONS CONSTRAINTS, CREW SAFETY, ORBITER FLYABILITY, SYSTEMS REQUIREMENTS/CONSTRAINTS.
SUN ELEV CONSTRAINTS (SOLAR)	VERBAL,WRITTEN	N/A	SUN ELEVATION ANGLE CONSTRAINTS RELATIVE TO SOLAR VIEWING PERIODS.
TV, PHOTO OPS HANDBOOK	DOCUMENT	PFDF	PFDF DOCUMENT CONTAINING CREW PROCEDURES ASSOCIATED WITH ON-ORBIT PAYLOAD TV AND PHOTO OPERATIONS.
TV, PHOTO SYSTEM CAPABILITIES	INFORMAL	N/A	DESCRIPTION OF THE NUMBER OF CAMERAS, DOWNLINK, ETC. AVAILABLE FOR PAYLOAD USE. INFORMAL AT FIRST, BUT FINALIZED IN THE ICD-B.
UPDATES TO MASTER INPUT FILES	VERBAL, WRITTEN	N/A	UPDATES MADE TO THE MASTER INPUT FILES BASED ON A DESKTOP OPERARTIONAL VERIFICATION OF THE ECOS MASTER TIMELINES.
UPDATES TO STL'S	VERBAL, WRITTEN	N/A	UPDATES MADE TO THE SUBORDINATE TIMELINES BASED ON A DESKTOP OPERARTIONAL VERIFICATION OF THE ECOS STL'S.